DEPARTMENT OF MINES.

MEMOIRS OF THE GEOLOGICAL SURVEY OF NEW SOUTH WALES.

C. S. WILKINSON, F.G.S., &c., GEOLOGICAL SURVEYOR-IN-CHARGE.

PALÆONTOLOGY, No. 4.

R. ETHERIDGE, JNR., PALÆONTOLOGIST.

THE FOSSIL FISHES

OF THE

HAWKESBURY SERIES AT GOSFORD.

BY

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LIST OF PLATES AND ILLUSTRATIONS.

Letter of Transmittal.

Geological Survey Branch,
Department of Mines,
Sydney, 1 March, 1890.

Sir,

I have the honour to submit Memoir No. 4 of the *Palæontological Series* of the Geological Survey of New South Wales, on the *Fossil Fishes of the Hawkesbury Series at Gosford*, by Mr. Arthur Smith Woodward, F.G.S., of the Geological Department, British Museum.

The collection of fossils therein described contains over four hundred specimens, the examination of which Mr. Woodward generously undertook; and I avail myself of the present opportunity of acknowledging our indebtedness to that able Palæontologist for his valuable work.

The discovery of fossil fish remains in the Hawkesbury Series at Gosford was made by Mr. Blunt, Railway Contractor, when opening a quarry for railway balast; but my attention was first called to their occurrence there by Mr. A. Lambert, who brought me a specimen showing the impression, not only of a fish, but also of a small Labyrinthodont. The latter has been described and figured by Professor W. J. Stephens, M.A., F.G.S., in the *Proceedings of the Linnean Society of New South Wales*, Vol. I (2nd Series).

I sent the Geological Survey Collector to the Gosford Quarry, and he succeeded in obtaining this splendid collection from a small bed of grey shale interstratified with beds of sandstone near the base of the Hawkesbury Series. The latter forms the middle division of the group which comprises, in descending order, the Wianamatta, Hawkesbury, and Narrabeen Series, and is considered to be of Triassic age.

Mr. T. W. E. David, B.A., F.G.S., who has examined the Gosford district, has furnished the accompanying Note on the geological horizon of the Fish-bed.

I have the honour to be,
Sir,
Your obedient servant,
C. S. WILKINSON,
Geological Surveyor-in-Charge.

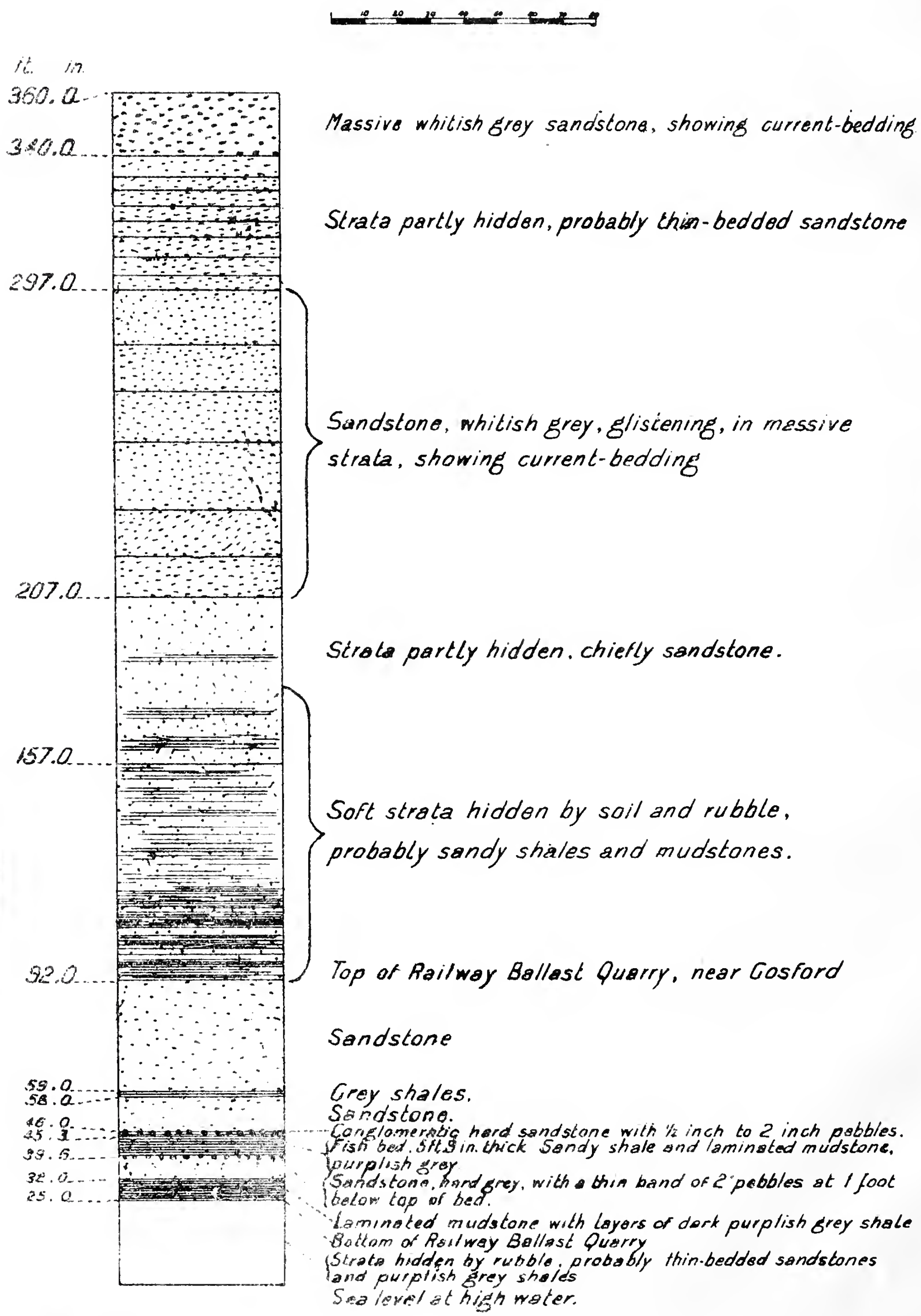
Harrie Wood, Esq., J.P.,
Under Secretary for Mines.

SECTION

OF HILL NEAR GOSFORD

at the base of which is the Railway Ballast Quarry, from which the remains of fossil fish & labyrinthodonts, described in this memoir, were obtained.

Scale of feet.



STRATIGRAPHICAL NOTE ON THE FISH-BED AT THE RAILWAY BALLAST QUARRY, NEAR GOSFORD.

EVIDENCE for determining the geological horizon of the Fish-bed in the above quarry is afforded by the diamond drill bores at Ourimbah and Wyong to the north, and Mullett Creek and the Jarley Borehole to the south, as well as by natural sections presented by the surrounding hills of Hawkesbury Sandstone.

The natural sections between the outcrops of the Permo-Carboniferous Coal Measures at Coal Cliff on the south, and Lake Macquarie on the north, show that Gosford is situated probably near the middle of the basin, as the strata here are nearly absolutely horizontal, whereas to the north of Gosford they have a general southerly dip, and at a short distance south of Gosford a northerly dip. At the Ourimbah Bore, six miles northerly from Gosford, 1,425 feet of strata were pierced by the diamond drill without the Coal Measures being reached. The greater part of the strata in this bore, between 450 and 1,150 feet, consist of fine shales of a chocolate, red, or green colour. Microscopic examination shows the green shales to be largely composed of tuffaceous material like the cupriferous shales proved in the Holt-Sutherland Bore, and it is probable that much of the chocolate and red shale is composed of altered tuffaceous material, intermixed with the sedimentary. At the Wyong Bore, ten miles northerly from the Ourimbah Bore, the Coal Measures were struck at a depth of $787\frac{1}{2}$ feet, the first 400 feet (approximately) being probably in the same strata which were proved in the lower portion of the Ourimbah Bore. Allowing an increase of about 650 feet of strata between the Ourimbah Bore and Gosford on account of the dip, the approximate thickness of strata intervening here between the Fish-bed and the Coal Measures would be about $650 + 1{,}425 + 387 = 2{,}462$ feet (approximately). The Mullet Creek Bore, about ten miles southerly from the Gosford Quarry, was carried to a depth of 1,338 feet without the Coal Measures being reached, the lower 500 feet being chiefly in chocolate and green shales. The depth to the Coal

Measures from the surface of this bore-hole is estimated by Mr. J. Mackenzie, F.G.S., the Examiner of Coal-fields, to be over 2,000 (probably 2,600 feet).* The horizon of the Fish-bed in this bore may be represented by the twenty feet (about) of chocolate shales struck at a depth of 315 feet.

The Jarley Bore at Mangrove Creek, Hawkesbury, penetrated to a depth of 482 ft. 3¼ in. without reaching the Coal Measures.† The strata of this bore cannot be correlated with those of the three bores already mentioned. A comparison of the Mullet Creek Bore with the Ourimbah suggests the possibility of the identity of the 150 feet of chocolate, blue, and green shales in the lower part of the former bore with the similar shales struck at 447 feet in the latter, and the 447 feet of sandstone, shale, and fine conglomerate in the latter may be identical with the 409 feet of "grey and brown sandstones and shales with *Phyllotheca*," in the former. In this case the depth of the Coal Measures below the Gosford Fish-bed (should the Newcastle Measures underlie this area) would be only about the same as Ourimbah, viz., about 1,800 feet.

The occurrence of such a thickness of sandstone, as proved in the Ourimbah Bore, below the level of the purplish grey shales and flaggy sandstones of the Gosford Fish-bed, renders it doubtful whether the bed belongs to the lower portion of the Hawkesbury Sandstone or to the upper portion of the Narrabeen Shales.

The details of the Section of the Railway Ballast Quarry show that the Fish-bed lies at the top of a group of flaggy hard sandstones, alternating with purplish grey shales with occasional thin bands of clay ironstone. This group, as proved by a neighbouring railway cutting, has a thickness of at least fifty feet. The flaggy sandstones are strongly ripple-marked, and the intercalated shaly beds contain numerous plant remains, too fragmentary, however, for identification. The purplish colour of these shales suggests that they may be composed partly of altered tuffaceous material like the purple shales of Holt-Sutherland and Bulli.

Capping these thin and even-bedded strata is a thickness of about eighty-five feet of massive coarse grey sandstones with patches of gravel, and a lenticular band of coarse pebbles immediately overlying the Fish-bed. The line of junction between the Fish-bed series and the coarse overlying sediments is

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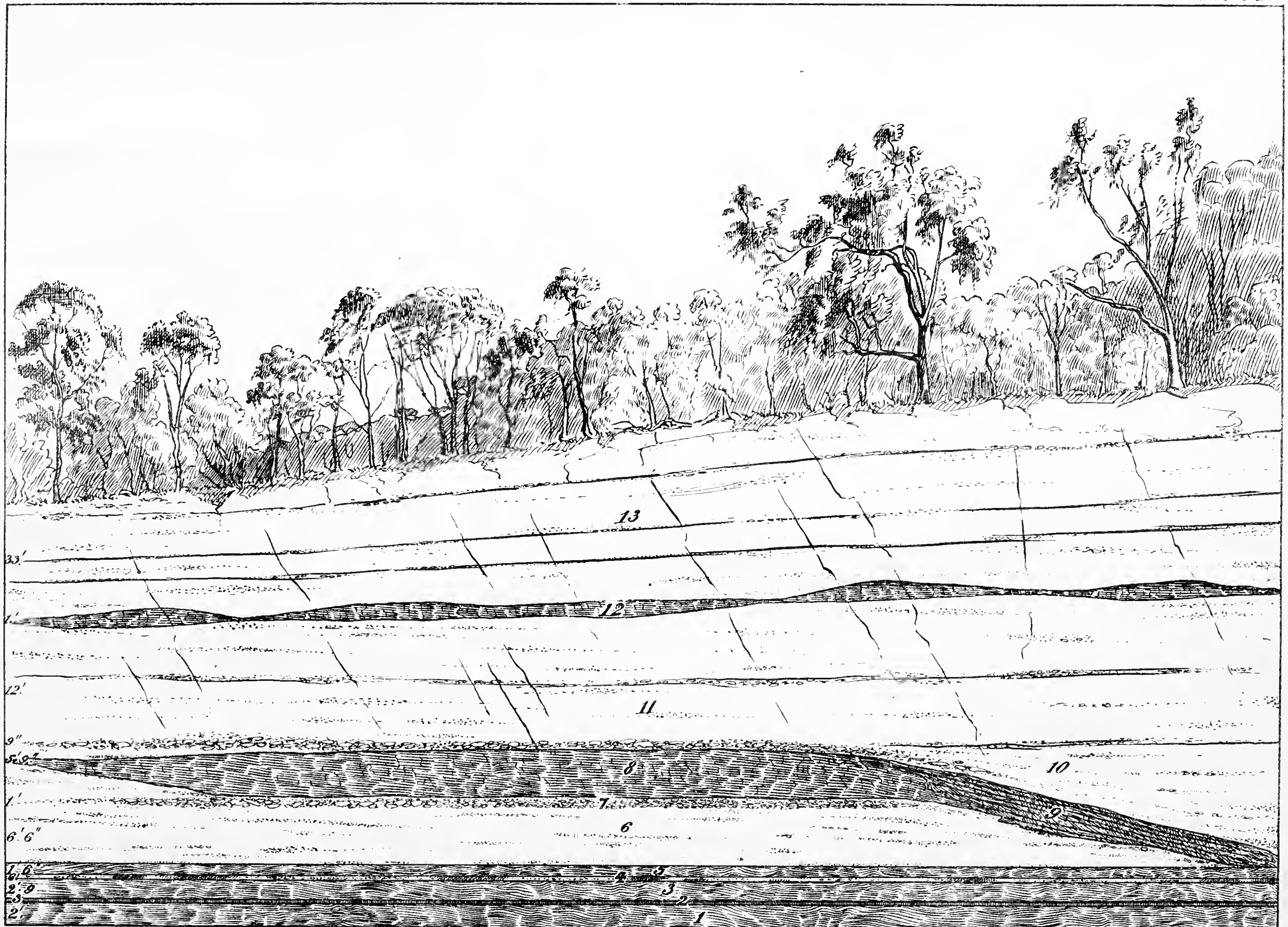
* Ann. Report Dept. of Mines, N. S. Wales, second plate, between pp. 208 and 209.
† Ann. Report Dept. of Mines, N. S. Wales, 1878, Plate No. 50.

also marked by slight contemporaneous erosion, as shown to the right of Plate B. Although the shales associated with the Fish-bed are probably partly tuffaceous, it is very improbable, to judge from the remarkable evenness and regularity of these strata, that the fish perished through an inflow of volcanic mud, or the falling of a shower of volcanic dust. The evidence quoted seems rather to favour the supposition that the fish, which evidently lived in some land-locked lake or sheltered estuary, where there was not sufficient current to efface the ripple marks, and where delicate plants could be preserved in the fine muds, were killed by the sudden silting up of the lake or estuary with thick beds of coarse sand and gravel swept down by powerful floods of fresh water.

T. W. EDGEWORTH DAVID.



P. T. Hammond del.
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EXPLANATION OF HORIZONTAL SECTION OF RAILWAY BALLAST QUARRY NEAR GOSFORD.

No. 1.—Ripple-marked flaggy sandstone and mudstone.

No. 2.—Clay ironstone, very argillaceous.

No. 3.—Ripple-marked flaggy sandstone and mudstone.

No. 4.—Ferruginous sandstone.

No. 5.—Ripple-marked flaggy sandstone and mudstone.

No. 6.—Sandstone.

No. 7.—Lenticular band of pebbles, 2 in. in diameter.

No. 8.—Laminated mudstone and sandy shales, dark purplish-grey. Fish and Labyrinthodont remains found here.

No. 9.—Laminated clayey-sandstone.

No. 10.—Sandstone, with lenticular band of pebbles ½ to 2 in. in diameter: dark quartz, jasperoid quartz, white quartz, greenish felsites (?), and mudstone.

No. 11.—Sandstone.

No. 12.—Lenticular grey shale.

No. 13.—Sandstone.

Vertical scale, 10 feet to 1 inch.

Editor's Preface.

The present Memoir on "The Fossil Fishes of the Hawkesbury Series at Gosford," in this Colony, by my former Colleague, Mr. Arthur Smith Woodward, F.G.S., F.Z.S., of the Department of Geology and Palæontology, Natural History Branch of the British Museum, forms No. 4 of the Palæontological Series of the Survey Memoirs.

It is satisfactory to find that the Triassic age, hitherto assigned to our Hawkesbury-Wianamatta Series, gains further support from Mr. Woodward's study of the Gosford Fish.

Mr. T. W. Edgeworth David, B.A., F.G.S., Geological Surveyor, has supplied a Chapter on the Stratigraphy of the beds as displayed at Gosford, and an Index to the Genera and Species, Contents, and List of Plates, &c., has been added by myself.

The Collection was made by Mr. Charles Cullen, Collector to the Survey.

R. ETHERIDGE, Jnr.

Sydney, March, 1890.

I.—INTRODUCTION.

The discovery of an early Mesozoic Fish-fauna in the Hawkesbury-Wianamatta beds of New South Wales is of considerable importance, not only from the stratigrapher's point of view, but also from the standpoint of philosophical Palæontology. Some slight information has already been obtained concerning the fishes of the supposed Trias and associated deposits of India, South Africa, and North America, as compared with the tolerably well-known fish-fauna of the equivalent formations in Europe; and it is thus of great interest to be able to study, in the light of known facts, corresponding fossils from another distant region. The series of nearly four hundred specimens, which form the subject of the present Memoir, were obtained from a layer of dark grey shale, four feet thick, interstratified with the massive beds of sandstone belonging to the Hawkesbury formation at Gosford, New South Wales; and though the majority of the fossils are too imperfectly preserved to exhibit many details of structure, almost all are capable of precise determination. In nearly every case, the substance of the bones and ganoid scales has disappeared, nothing being distinguishable except mineral-stained impressions.

The first scientific notice of the Hawkesbury fishes appears to be a brief paper by Professor J. D. Dana,* who made known a single species of a peculiar Palæoniscid genus, *Urosthenes*, from Newcastle, on the Hunter River; and fifteen years later, Sir Philip de Malpas Grey Egerton † added further notes upon this fossil, while describing five other specimens from Cockatoo Island, Parsonage Hill, near Parramatta, and Chapel Hill, near Campbelltown. The last-named specimens were discovered by the late Rev. W. B. Clarke, who forwarded two to Sir Philip, with photographs of the three others; and these furnished one new genus and species of Palæoniscidæ (*Myriolepis Clarkei*), in addition to a supposed species of *Palæoniscus* itself

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* J. D. Dana, "Fossils of the Exploring Expedition under the command of Charles Wilkes, U.S.N." Amer. Journ. Sci., 1848, [2] Vol. v, pp. 433, 434.

† Sir Philip de Malpas Grey Egerton, "On some Ichthyolites from New South Wales, forwarded by the Rev. W. B. Clarke," Quart. Journ. Geol. Soc., 1864, Vol. xx, pp. 1–5, Pl. i.

(*P. antipodeus*), and another new genus and species (*Cleithrolepis granulatus*), now known to pertain to the Dapedioid section of the Semionotidæ. Of *Urosthenes australis*, Dana, and *Palæoniscus antipodeus*, Egerton, there appear to be no representatives in the Geological Survey Collection sent to me; but of the other genera examples are numerous and satisfactorily preserved.

The discovery of the present collection has already been placed on record by Prof. W. J. Stephens,* who has described Labyrinthodont remains from the same formation.

* W. J. Stephens, "On some Additional Labyrinthodont Fossils from the Hawkesbury Sandstone of New South Wales," Proc. Linn. Soc. N.S.W., 1887, [2] Vol. ii, p. 156.

II.—DESCRIPTION OF THE GENERA AND SPECIES.

Class—**Pisces.**

Order—SELACHII.

Family—CESTRACIONTIDÆ.

Genus non det.

Obs.—An imperfect fossil, 0·33 in length, indicates the presence of a Selachian in the Hawkesbury beds, but does not exhibit sufficiently characteristic features for its generic determination. Each of the two dorsal fins of the fish is armed with a formidable spine; and the body is evidently covered with dense shagreen. The first dorsal fin-spine is much arched and sharply pointed, measuring 0·06 in length, and about 0·008 in breadth at the base; and there are some faint appearances of tubercles, suggesting a surface-ornament of longitudinal nodose ribs. The second dorsal spine is placed 0·175 behind the first, but only the base is preserved. The shagreen-granules are deeper than broad; and these seem to have been transversely ribbed or pectinated.

The discovery of satisfactory specimens of this Shark will prove of much interest, for the few features discernible—especially the characters of the shagreen—are very suggestive of a British Carboniferous Selachian, *Sphenacanthus*.* Teeth indistinguishable from the late Palæozoic *Diplodus* occur in the English Keuper†; the dorsal fin-spine, *Nemacanthus*, of the Rhætic has the posterior denticles laterally placed, as in all Palæozoic spines; and the Rhætic teeth, named *Hybodus minor*, have the base so much horizontally expanded that they would be assigned to *Cladodus* if found in the Carboniferous. But no undoubted proof of a Palæozoic Selachian genus

* L. Agassiz, Recherches sur les Poissons Fossiles, 1837, Vol. iii, p. 23. Provisionally defined in the Catalogue of the Fossil Fishes in the British Museum, 1889, Part I, p. 241.

† Smith Woodward, "On *Diplodus Moorei*, sp. nov., from the Keuper of Somersetshire," Ann. Mag. Nat. Hist., 1889 [6], Vol. iii, pp. 299, 300, Pl. xiv, figs. 4, 5.

surviving in the Mesozoic has hitherto been obtained; and the Hawkesbury genus will be noteworthy, if future discoveries confirm the impressions derived from the fossil just described.

Order.—DIPNOI.

Family.—UNCERTAIN.

Genus—GOSFORDIA, *gen. nov.*

Gen. Char.—Head very small; snout pointed; trunk elongate, though comparatively deep, laterally compressed; median fin continuous; pelvic fins acutely lobate, biserially fringed; scales very small, delicate, overlapping, marked by fine striæ.

Obs.—Though thus imperfectly known, the generic distinctness of this fish from all other Dipnoans as yet sufficiently defined seems tolerably evident. If *Phaneropleuron* belongs to the Dipnoan order, it is readily distinguished by the separate anal fin; and the only other genera with which it seems necessary to institute comparisons are *Conchopoma*,* *Ctenodus*,† and the recent *Ceratodus*.‡ All of these have the continuous median fin, and exhibit several striking features of resemblance to the Hawkesbury fish; but a detailed comparison of the new fossil shows that it cannot be comprised in either of them.

The scales of *Conchopoma* are certainly very similar to those of *Gosfordia*,§ and the absence of traces of teeth in the original of Pl. I, Fig. 1, suggests that they may have been comparatively small in the Australian fish, as in the European Permian genus. The head, however, is relatively so much less in *Gosfordia* than in *Conchopoma*, and the operculum so different in shape, that other features, yet to be discovered, will doubtless combine to render the generic distinctness of these two forms most marked.

Ctenodus, and the living fish named *Ceratodus*, are both separated by the large size of the scales; but it still remains to be decided whether or not

* R. Kner, "Ueber *Conchopoma gadiforme*, nov. gen. et spec.," Sitzungsb. math. Naturw. Cl. k. Akad. Wiss., 1868, Vol. lvii, Pt. i, pp. 278–290, Pls. i–iv.

† The latest memoir upon this genus is by Anton Fritsch, "Die Lurchfische, Dipnoi," forming Pt. 3 of Vol. ii of the "Fauna der Gaskohle, etc., Böhmens" (1888).

‡ A. Günther, "Description of *Ceratodus*," Phil. Trans., 1871, pp. 511–571, Pls. xxx–xlii.

§ The writer has been able to verify this fact by a personal examination of the type-specimens of *Conchopoma* in Berlin and Strassburg.

the fossil teeth originally termed *Ceratodus**, truly pertain to the fish now described. Though an imperfect tail of the early Mesozoic *Ceratodus* has already been made known,† and a tolerably complete skull briefly noticed,‡ there is yet no decisive proof of the generic identity of the extinct and living species; and future discoveries may thus eventually relegate *Gosfordia* to the synonymy of *Ceratodus* proper, and justify the adoption of a new name for the existing fish of the Queensland rivers.

GOSFORDIA TRUNCATA, *sp. nov.*

Pl. I; Pl. II, Figs. 1, 2.

Obs.—Of this genus and species no complete fish is known; but, in addition to less satisfactory fragments, the following series of specimens exhibits many of the chief features in its skeletal anatomy:—

(*a*) Head and anterior portion of the trunk, shown of one-half the natural size in Pl. I, Fig. 1.

(*b*) The greater portion of the trunk to the tip of the tail, shown of one-half the natural size in Pl. II, Fig. 1. This and the preceding are the type-specimens.

(*c*) A portion of the axial skeleton of the trunk.

(*d*) Terminal portion of the trunk, with the median fin and one of the pelvic pair, shown of the natural size in Pl. I, Fig. 2.

(*e*) Fragment, with fin-rays (Pl. II, Fig. 4).

General Form.—The head is remarkably small and triangular. Immediately behind it, the trunk rapidly deepens, and in the original of Pl. I, Fig. 1, the maximum width of the crushed head (0·08) becomes no less than 0·19 at a point 0·17 distant nearer the tail. The total length of a fish of these proportions is probably not less than 0·6, and its lateral compression is indicated by the invariable display of a side-view in the fossils.

Head and Opercular Apparatus.—The only specimen exhibiting the head (Pl. I, Fig. 1), is in a very imperfect state of preservation, and does not admit of the determination of any structural features. Its relatively small proportions, however, are well shown. A faint groove and ridge (*x*) mark

* L. Agassiz, Rech. Poiss. Foss., 1838, Vol. iii, p. 129.

† *Cœlacanthus giganteus*, T. C. Winkler, Archiv. Mus. Teyler, 1880, Vol. v, pp. 141–147, Pl. ix.

‡ D. Stur, "Vorlage des ersten fossilen Schädels von *Ceratodus* aus den obertriasischen Reingrabner Schiefern von Pölzberg nördlich bei Lunz," Verh. k.k. Geol. Reichsanst. Wien, 1886, pp. 381–383.

the posterior margin either of the opercular bones or the pectoral arch; a hollow (*orb.*) seems to indicate the position of the orbit; the roof of the skull is flattened, and the snout is sharply pointed. No teeth are distinguishable, and it seems likely that they were small.

Axial Skeleton of Trunk.—The notochord, as usual, was persistent; and the cartilages of the neural and hæmal arches and spines—as also the interspinous cartilages—were evidently only superficially calcified, these being often represented in the fossils by a large core of calcite surrounded by a thin film of skeletal matter, well shown in the figures. The neural arches and spines are short and stout; and in the caudal region the hæmal arches and spines are similar. Long, slender, gently arched ribs are well shown in the abdominal region, arranged in series as far as its termination almost immediately above the pelvic fins; and in the type specimens there are about three pairs of these ribs in the space of 0·02.

Appendicular Skeleton.—Of the paired fins, only one of the pelvics is preserved (Pl. I, Fig. 2, *plv.*); and a few robust fin-rays exhibited by a fragmentary fossil (Pl. II, Fig. 2) may pertain either to these fins or to the pectoral pair. Each pelvic fin is acutely lobate, its length being more than three times as great as its maximum breadth; and the long lobe is fringed in the usual manner with stiff fin-rays. The median fins form a continuous fringe round the hinder end of the body and are supported by a double series of interspinous bones, the elements of the proximal series being about twice the length of the distal. The interspinous bones appear to be even stouter than the neural and hæmal spines to which they are apposed; and those of the proximal series, at least, have broadened ends.

Squamation.—The tissues of the body have become converted into a black granular material, and the scales being very delicate, they are thus only recognizable with difficulty. The precise outlines of the scales cannot be distinguished in any specimen; but they are evidently very small, and all are marked by fine longitudinal striations.

Order—**GANOIDEI.**

All the fishes of the Hawkesbury-Wianamatta Series referable to the hyostylic type, with true bones, fall under the denomination of Ganoidei, as defined and determined by Agassiz. In the prevailing uncertainty as to the correct limits and nomenclature of the great groups of fishes of this type, we simply adopt the term for convenience, awaiting the further development of palæontological research to confirm or modify the apparently now reasonable classification of Cope.*

The subdivisions of the Ganoids are still equally under dispute, and it will suffice for the present Memoir, which deals only with actinopteran families (*i.e.*, those in which the paired fins are non-lobate), to distinguish between that type in which the interspinous bones of the median fins are fewer in number than the apposed dermal fin-rays, and the more specialized type in which each fin-ray has a separate support. As remarked, especially by Cope,† the stages presented by the development of the appendicular skeleton, are of great taxonomic significance; and it may now be regarded as proved, that the "crossopterygian" limb and the non-correspondence of the ends and exo-skeleton in the median fins are marks of inferiority of generalization. The heterocercal tail likewise persists in many cases untilthe "actinopteran" limb has been developed (Palæoniscidæ); but as soon as there is a tendency towards the correlation of the interspinous bones and the median fin-rays, the upper lobe gradually atrophies and externally disappears.

A.—Ganoids in which the dorsal and hæmal interspinous bones are less numerous than the apposed dermal fin-rays.

(i).—Caudal fin heterocercal.

Family—PALÆONISCIDÆ.

Fam. Char.—Body elongate, fusiform; scales, when present, rhombic (rarely in part cycloidal), enamelled; dorsal fin rarely remote. Head-bones well-developed, externally enamelled; eye far forwards, and snout prominent; mandibular suspensorium more or less oblique, and the mouth deeply cleft. A series of broad branchiostegal rays, the most anterior pair especially large, with a small median element.

Genus—MYRIOLEPIS, *Egerton*, 1864.

(Quart. Journ. Geol. Soc., Vol. xx, p. 3.)

Gen. Char.—Head large, snout obtuse; suspensorium oblique; gape very wide, with the teeth large and conical; fins well-developed, the dorsal high and triangular in form, placed opposite the space between the pelvis

* E. D. Cope, "Observations on the Systematic Relations of the Fishes," Proc. Amer. Assoc. Adv. Sci., 1871, p. 326.

† E. D. Cope, Review in Amer. Naturalist, 1887, p. 1015.

and the anal; anal fin also short and triangular; upper lobe of tail much produced, the caudal fin being powerful and deeply forked; small fulcra present upon all the fins. Scales very small [superficially striated, *Egerton*]; large oat-shaped scales, finely striated, upon the sides of the caudal lobe, and prominent fulcral scales upon its upper border.

Obs.—This genus was founded by Sir Philip Egerton upon the middle portion of a fish destitute of fins, from Chapel Hill, near Campbelltown, and upon the anterior half of another similar fish from Cockatoo Island, only known to him by a photograph transmitted by the Rev. W. B. Clarke. The characters, so far as discernible, were considered to denote a close relationship with *Acrolepis*, thus placing the genus in the family of the Palæoniscidæ; and this interpretation has subsequently been generally adopted. The specimens in the present collection now render it possible to complete the diagnosis as given above; and, though exhibiting but few anatomical details, they make known the general features of at least two well-marked species.

A careful study of the new fossils suggests the comparison of *Myriolepis* with *Thrissonotus*,* from the Lower Lias of Lyme Regis, Dorsetshire, the only essential difference in the single known specimen of the English Liassic genus being the considerable elongation of the anal fin.

Myriolepis Clarkei, *Egerton*.

Pl. II, Figs. 3, 4; Pl. III, Figs. 1.

Myriolepis Clarkei, Egerton, Quart. Journ. Geol. Soc., 1864, vol. xx., p. 3, Pl. I, fig. 1.

Obs.—The type species is represented by several fossils, pertaining both to old and young individuals, and the information afforded by the following five specimens is of especial value:—

(*a*) A large complete fish, probably about 0·435 in length, and shown of half the natural size in Pl. II, Fig. 3. (The specimen has been broken across, immediately behind the pelvic fins, and the wrong halves of the counterpart unfortunately united, leaving a gap in the middle that did not exist originally. The figure is thus in part restored, with the help of Egerton's drawing already quoted.)

* Sir Philip de M. Grey Egerton, "Figures and Descriptions of British Organic Remains," Mem. Geol. Surv. Gt. Brit., 1858, Dec. ix, No. 2, Pl. ii.

(*b*) Head and pectoral fin of a smaller individual, shown of the natural size in Pl. III, Fig. 1.

(*c*) Imperfect head and trunk of a small individual, 0·215 in length.

(*d*) Dorsal fin of a large individual, shown of the natural size in Pl. II, Fig. 4.

(*e*) Caudal pedicle, with portions of the caudal and anal fins.

General Form.—The largest specimen (Pl. II, Fig. 3), measures at least 0·435 in length, and of this the head and opercular apparatus extend about 0·09. The trunk is of almost uniform depth as far as the dorsal fin, equalling perhaps 0·095; and the caudal region gradually tapers to a stout caudal pedicle, produced terminally into a large upper lobe. All the fins are large and powerful.

Head and Opercular Apparatus.—Nothing can be discerned of the cranial bones or the suspensorium, but the marked obliquity of the latter is indicated both in Pl. II, Fig. 3, Pl. III, Fig. 1, and in No. *c*. The deeply cleft character of the gape is also very evident, and some indications of the elements of the upper jaw are observable in the second fossil. A very short tooth-bearing element, probably the premaxilla, occurs in front, at the extremity of the snout (Pl. III, Fig. 1, *pmx.*); and a large narrow, but gradually widening, impression behind seems to be due anteriorly to the maxilla (*mx.*), and posteriorly to the palato-pterygoid arcade, the former half being provided with small conical teeth like those of the premaxilla. The lower jaw is somewhat shorter than the upper; but the dentary element (*d*) is relatively long and slender, and this bears a few widely-spaced conical teeth of larger size than any exhibited in the opposing dentition.

Behind the head, indications of the opercular apparatus are observed, of comparatively small dimensions. Unless appearances in No. *b* (Pl. III, Fig. 1) are deceptive, the operculum (*op.*) is very small and triangular, while the suboperculum (*s.op.*) is at least twice as deep, quadrilateral, and of uniform breadth. Remains of some of the branchiostegal rays (*br.*) are preserved beneath, quite of the ordinary Palæoniscid character.

Appendicular Skeleton.—In all the fins, the rays are broad and much flattened, with a longitudinal median keel; and, except perhaps in front of the pectorals, they are articulated, and divide distally into fine filaments. In each of the fins, except the caudal, the anterior rays are gently arched; and although distinct small fulcra can rarely be discerned, various indications prove the original presence of these structures. The pectoral fins are large and triangular, perhaps almost falcate; and the pelvic fins, of about half the size, exhibit a relatively long base-line, and are placed midway between the pectorals and the anal. The dorsal fin (Pl. II, Fig. 4) shows in front at least nine large basal fulcral rays, gradually increasing in length, and its base-line is greater than its height. The anal fin is slightly smaller than the latter, but equally elevated; and in the original of Pl. II, Fig. 3, a few of the small anterior fulcra can be distinguished. The caudal fin is deeply cleft, and the rays of the lower lobe are very closely articulated even near the proximal extremity.

Squamation.—The scales are extremely small, those of the flank, in an individual 0·435 in length, not measuring more than 0·0015 in depth and breadth. Ventrally, they become narrow, and upon the upper lobe of the tail oat-shaped or diamond-shaped; and Sir Philip Egerton describes them as externally sculptured by "two or three deep longitudinal sulci." The present specimens, however, are too imperfectly preserved to exhibit any scale ornament, except faint striations upon the investment of the upper caudal lobe; and the only ridge-scales to be observed occur upon the superior border of this prolongation, where they are very prominent, and pass upwards into the fin-fulcra.

MYRIOLEPIS LATUS, *sp. nov.*

Pl. III, Figs. 2, 3.

Obs.—A second species of *Myriolepis* is indicated by a small series of specimens, of which the following three are the most important:—

(*a*) The complete head and trunk, wanting all fins, except the anal and caudal, to be regarded as the type-specimen, and shown slightly reduced in Pl. III, Fig. 2.

(*b*) The greater portion of the head and trunk, lateral aspect, with fragments of the pectoral, pelvic, and anal fins, the former in the relative positions indicated in dotted outline in the figure of No. *a*.

(*c*) Portion of the head and anterior portion of the trunk, showing the left infraclavicle, outer aspect. (Pl. III, Fig. 3.)

General Form.—The type-specimen (Pl. III, Fig. 2) measures 0·265 in length, and is perhaps as large as any indicated in the collection. Compared with *M. Clarkei*, the fish is much less elongated, the greatest depth of the trunk being only comprised a little more than three and a half times in the total length, the fins are less powerful, and the scales are exactly twice as large in proportion.

Head and Opercular Apparatus.—No details of cranial osteology can be deciphered, and little beyond the general form of the head is determinable. In accordance with the other proportions of the fish, it is relatively shorter than in *M. Clarkei*, and the mandible perhaps stouter. An element of the upper jaw, either the maxilla or the palato-pterygoid, is long and narrow, though deepest behind, and remains of the actual maxilla in No. *c* show that it was externally ornamented by large rugæ and tubercles. The dentary bone, bearing at least a few spaced conical teeth, is superficially ornamented by striations parallel to its long axis.

Appendicular Skeleton.—At the postero-inferior angle of the lower jaw in No. *c*, a large, elongated, triangular bone is observed, evidently to be regarded as the left infraclavicular element of the pectoral arch. This bone is shown of twice the natural size in Pl. III, Fig. 3, the short base-line being posteriorly and the apex anteriorly directed, and its external surface is ornamented by coarse, rounded, radiating rugæ, proceeding upwards and downwards from an unsymetrically-placed longitudinal ridge. The form and proportions of the other bones of the pectoral arch cannot be determined, and in the figure of the type-specimen (Pl. III, Fig. 2) the positions of the paired fins can only be partially marked by dotted lines, based upon the evidence of a second fossil, No. *b*. None of the fins are capable of description, but, so far as determinable, they agree well with those of *M. Clarkei.*

Squamation.—The size of the scales renders it easily possible to observe their variations in form. Upon the flanks they are deeper than broad, and in a specimen 0·265 in length, the antero-posterior measurement of each is about 0·002. Ventrally, all the scales become much broader than deep, and upon the upper lobe of the tail they are diamond-shaped and elongated. There is also a singular feature, well displayed in the type-specimen (Pl. III, Fig. 2), immediately above the anal fin, about nine series of scales being reflexed forwards, as in the Platysomidæ.

Genus—APATEOLEPIS, *gen. nov.*

Gen. Char.—Body slender; head of moderate size; snout prominent; suspensorium very oblique, and gape wide; teeth minute. Fins well-developed; the dorsal very high, triangular in form, with a short base-line placed opposite the space between the pelvics and the anal; anal fin also triangular, with a short base-line; upper lobe of tail much produced, the caudal fin being powerful and deeply forked; fulera absent. Scales of the trunk rhomboidal, extremely delicate, marked by two or three diagonal ridges; those upon the sides of the upper lobe of the tail thicker, oat-shaped, similarly ornamented; a prominent fulcral series upon the superior margin of the caudal lobe.

Obs.—This new genus of Palæoniscidæ may appropriately receive the name of *Apateolepis,* in allusion to the deceptive character of its squamation. The scales of the whole of the body except the upper caudal prolongation, are so delicate that they are either only imperfectly preserved, or completely destroyed; and the latter is so often the case, that one might at first sight suspect a resemblance to the extinct *Chondrosteus* and the modern *Polyodon*, in having the squamation exclusively confined to the caudal lobe.

Only two Palæoniscidæ of a similar type seem to have been hitherto discovered; and it is interesting to know that both of these agree with the present form in the singular absence of fin-fulera. The first genus is that described by Dr. Traquair, from the Lower Carboniferous of Eskdale, Dumfriesshire (Scotland), under the name of *Phanerosteon**; and the second is a fish from the Erie Shale of Ohio, more recently briefly noticed by Dr. Newberry under the name of *Actinophorus*†. According to Dr. Traquair, *Phanerosteon* was quite destitute of scales upon the flank, with the exception of a few thin examples immediately behind the pectoral arch; and this genus is still further distinguished from *Apateolepis* by the character of the dorsal fin, and the less pronounced bifurcation of the caudal. *Actinophorus* is a long, slender fish, with pointed head, attaining a much greater size than either of the foregoing; and though the whole of the flank is covered by thin quadrangular scales, these, according to the definition, will differ from those of *Apateolepis* at least in their narrowness.

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* R. H. Traquair, "Report on Fossil Fishes collected in Eskdale and Liddesdale," Trans. Roy. Soc. Edinburgh, 1881, Vol. xxx, pp. 39–43, Pl. iii, figs. 6–8.

† J. S. Newberry, "The Fish Fauna of the Erie Shale of Ohio," Trans. New York Acad. Sci., 1888, Vol. vii, No. 7.

Apateolepis australis, *sp. nov.*

Pl. IV, Figs. 1–4.

Obs.—All the examples of *Apateolepis* hitherto met with in the Hawkesbury beds are referable to a single species, of which the following specimens exhibit some of the principal characters:—

(*a*) Nearly complete fish, wanting the paired fins, shown of the natural size in Pl. IV, Fig. 1. (Type specimen.)

(*b*) Imperfect fish, viewed in part from the ventral aspect, displaying portions of all the fins, and shown of the natural size in Pl. IV, Fig. 2.

(*c*) Specimen in counterpart, showing the greater portion of the fish, with remains of all the fins, and faint indications of long slender neural arches and spines.

(*d*) Tail, shown of the natural size in Pl. IV, Fig. 3.

(*e*) Fragment showing flank-scales, of which some are enlarged six times in Pl. IV, Fig. 4.

General Form.—The type-specimen measures about 0·18 in total length, and about 0·03 in maximum depth, the trunk being thus comparatively slender, and more than four times as long as the head with the opercular apparatus. The upper lobe of the tail is much elongated, though robust. The dorsal fin is placed over the posterior portion of the pelvic pair, and well in advance of the anal.

Head and Opercular Apparatus.—That the head is typically that of a Palæoniscid is evident; but no precise details of structure are capable of determination. In the type-specimen (Pl. IV, Fig. 1), an element of the upper jaw is faintly indicated, and may probably be regarded as the pterygo-palatine arcade (*pt. pl.*); and in the same fossil, the mandible is imperfectly shown, being probably somewhat broken in front and artificially deepened by crushing. A longitudinally-striated element, evidently the dentary (*d*), is recognizable; and there are traces of minute teeth in both jaws. The operculum (*op.*) is small, quadrangular, and irregularly rhomboidal in form; and the suboperculum (*s. op.*) is a somewhat larger bone, exceeding the operculum in breadth, if not also in depth.

Axial Skeleton of Trunk.—In most examples of *A. australis*, there is distinct evidence of the persistence of the notochord, and in some specimens (*e.g.*, Nos. *a* and *c*) indications of long, slender neural arches and spines can be distinguished. As usual among the Palæoniscidæ, there is no evidence of ribs; and the only remains of hæmal arches are four stout bones, with slightly expanded extremities, supporting the lower lobe of the caudal fin in the type-specimen (Pl. IV, Fig. 1).

Appendicular Skeleton.—Of the pectoral arch, the supraclavicle, clavicle, and infraclavicle are shown also in the type-specimen (Pl. IV, Fig. 1). The supraclavicle (*s. cl.*) is nearly four times as long as its maximum breadth; the upper extremity is narrowest, and immediately below this is a slight rounded excavation of the posterior margin, whence the bone very gradually expands downwards and is radiately striated. The clavicle (*cl.*) is bent forwards as ordinarily, at a point much nearer the inferior than the superior extremity, and there is either a flexure or thickening of the anterior concave margin. The ascending limb is pointed above, narrow, with the hinder margin gently curved, and the surface is marked by fine striæ not precisely parallel to its long axis, but slightly sloping forwards; the lower limb is short, broad, and expanded, and exhibits similar but radiating striæ. The infraclavicle is a large triangular bone, elongated antero-posteriorly, and partly seen beneath the posterior portion of the mandible; a longitudinal ridge traverses its superior portion, and from this below there radiate numerous coarse rugæ.

The pectoral fins are best shown in No. *b* (Pl. IV, Fig. 2), where one is of triangular form, and seems to be nearly complete, though comprising only about twenty rays. Of the "pelvic" bones there is no trace in any specimen; but the pelvic fins are well preserved in Nos. *b* (Pl. IV, Fig. 2) and *c*, and they were evidently of considerable size, though still somewhat smaller than the pectorals. Not less than thirty rays can be counted in one of these fins in No. *c*.

The median fins are all acuminate, and consist of numerous, closely apposed rays. Though apparently complete in the type-specimen (Pl. IV, Fig. 1), the dorsal and anal fins were probably somewhat larger than those of this fossil, another (Pl. IV, Fig. 2) exhibiting relatively longer rays in the anal, and a third (No. *c*) displaying a greater number of rays in both fins. In the type, the dorsal fin comprises about forty-five rays, and the anal not more than thirty-five, whereas in No. *c*, the corresponding numbers are at least sixty and forty; but in either case, the dorsal appears to be the larger fin of the two, and is placed entirely in advance of the anal. In the dorsal fin, the most anterior rays gradually increase in length to the twelfth, which is longest, and the rapid shortening of those that follow is such as to make the posterior margin much more abrupt than the anterior; in the anal fin, the maximum length is attained by about the ninth ray, and the shortening of the rays in either direction is precisely like that observed in the dorsal. Each of these fins is distinctly supported by a series of stout interspinous bones, with somewhat expanded extremities, much less numerous than the rays; the anal fin of the type-specimen exhibiting only ten bones apposed to at least twenty-five of the rays.

The caudal fin (Pl. IV, Figs. 1, 3) is deeply forked, and the lower lobe consists of about forty rays.

All the fin-rays are delicate, laterally compressed, and articulated at more or less distant intervals; and many, if not all, are bifurcated distally. In the best preserved fins there are no indications even of minute fulcra.

Squamation.—The scales of the flanks are extremely delicate, rhomboidal in form, as deep as broad, and ornamented by two prominent diagonal ridges, which are not parallel, but often meet in front and are most widely separated mesially. In most specimens the obscure remains of these ridges constitute the only evidence of the original presence of scales; but one small fossil, No. *e*, is more satisfactory, and a few of the actual scales are shown, of six times the natural size, in Pl. IV, Fig. 4. The scales upon the sides of the upper caudal lobe (Pl. IV, Figs. 1, 3) are much thicker than those of the remainder of the body. They also exhibit the characteristic oat-shaped form, and are diagonally ridged.

(ii)—Caudal fin semi-heterocercal.

Family—CATOPTERIDÆ.

Fam. Char.—Body elongate; scales rhombic, enamelled; dorsal fin remote; head-bones well developed, externally enamelled; eye far forwards, and snout prominent; suspensorium oblique, and mouth deeply cleft.

Obs.—The genera *Catopterus*, Redfield,* and *Dictyopyge*, Egerton,† have been associated in recent years with *Acentrophorus* and *Semionotus*

* J. H. Redfield, "On the Fossil Fishes of Connecticut and Massachusetts," Ann. Lyc. Nat. Hist. New York, 1848, Vol. iv, p. 37, Pl. i.

† In C. Lyell, "On the Structure and Probable Age of the Coal-field of the James River, near Richmond, Virginia," Quart. Journ. Geol. Soc., 1847, Vol. iii, p. 276.

(=*Ischypterus*), as the forerunners of the Lepidosteoidei, in which there is no infraclavicle, and in which the rays of the median fins correspond in number with their supporting ossicles. It is unfortunate, indeed, that the state of preservation of the known specimens does not permit of these characters in the osteology being clearly ascertained; but a study of the new fossils from the Hawkesbury beds, in the light of examples already described from the European and American Trias, is so suggestive of intimate relationship with the Palæoniscidæ, that we venture to suggest an emendation of the now-accepted arrangement of these fishes.

If Mr. Dinkel's drawings of *Dictyopyge macrura** be correct, the number of the fin-rays in the anal fin is distinctly greater than that of the supporting interspinous bones; and the fish is therefore excluded, by accepted definitions, from the "Lepidosteoidei," and falls with the Palæoniscidæ into the "Acipenseroidei" (Traquair), or "Heterocerci" (Zittel). One of the Australian fossils (*D. illustrans*, Pl. IV., Fig. 7) exhibits a large triangular bone beneath the back of the mandible, which seems most satisfactorily compared with the Palæoniscid infraclavicle; and the vaguely discernible features of the head also bear a very striking resemblance to the corresponding parts in the Palæoniscidæ. Moreover, the tail in the new specimens (Pl. IV., Fig. 9) is slightly more heterocercal than has hitherto been observed in this genus.

It is therefore proposed to place *Catopterus* and *Dictyopyge* in a distinct family, the Catopteridæ to be assigned to whatever great subdivision of the "Ganoids" is made to include the Palæoniscidæ and their allies.

Genus—DICTYOPYGE, *Egerton*, 1847.

(Quart. Journ. Geol. Soc., vol. iii., p. 276).

Gen. Char.—Head small, or of moderate size; gape very wide; teeth minute and conical. Fins with distinct fulcra; dorsal opposite to, or immediately in advance of the anal; caudal fin forked. Scales rhombic, as deep as broad upon the flank, broader than deep ventrally, the exposed surface smooth, or with few oblique ridges or furrows. Ridge-scales absent.

Obs.—As remarked by Traquair,† *Dictyopyge* is only distinguished from *Catopterus*, so far as known, by the position of the dorsal fin;

* Quart. Journ. Geol. Soc., Vol. iii., Pl. viii., Pl. ix., fig. 1.

† R. H. Traquair, "On the Agassizian Genera *Amblypterus*, *Palæoniscus*, *Gyrolepis*, and *Pygopterus*," Quart. Journ. Geol. Soc., 1877, Vol. xxxiii, p. 567.

this appendage in the former genus being partly in advance of, or directly opposed to, the anal fin, while in *Catopterus* it arises opposite the hinder portion of the anal, or is completely behind. Such a character may be provisionally regarded as sufficient for generic distinction; and of *Dictyopyge*, as thus defined, five species are already known. These have been obtained from the Trias of Virginia, U.S.A.,* and of Tyrone, Ireland,† the Bunter of the Rhine Valley,‡ the Keuper Sandstone of Coburg, Germany,§ and the Upper Keuper Sandstone of Warwickshire, England.||

The most important descriptions of the genus are those of Traquair (*loc. cit.*) and Strüver (*loc. cit.*); and the fossils from the Hawkesbury beds do not add any very definite information concerning new structural features, although, as observed above, some appearances are suggestive of interesting novel points, to be verified or disproved by future discoveries. One fact, however, seems certain, namely, that Strüver's restoration of *D. socialis* is incorrect in representing the mandibular suspensorium as vertical or even inclined forwards, all specimens that the writer has examined, whether European, American, or Australian, exhibiting a suspensorium as much inclined backwards as in many specialized Palæoniscidæ.

DICTYOPYGE SYMMETRICA, *sp. nov.*

Pl. IV, Figs. 5, 6.

Obs.—The smallest of the Australian species of *Dictyopyge* is represented by specimens exhibiting but few details of structure, and the following four examples show all the features discernible:—

(*a*) Type-specimen (Pl. IV., Fig. 5.)
(*b*) Nearly complete fish, wanting the upper half of the caudal fin (Pl. IV., Fig. 6.)
(*c*) Complete trunk, wanting paired fins.
(*d*) A smaller fish, showing parts of the fins, especially the pectoral.

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* *Dictyopyge macrura*, Egerton, *loc. cit.* *Catopterus macrurus*, W. C. Redfield, Amer. Journ. Sci., 1841, Vol. xli, p. 27, and Proc. Amer. Assoc. Adv. Sci., 1856, pp. 180–188.

† *D. catopterus*, R. H. Traquair, Quart. Journ. Geol. Soc., 1877, Vol. xxxiii, p. 565. *Palæoniscus catopterus*, Egerton, *ibid.*, 1850, Vol. vi, p. 4.

‡ *D. rhenana*, W. Deecke, Palaeontographica, 1889, Vol. xxxv, p. 107, Pl. vi, fig. 11.

§ *D. socialis*, Berger, sp., described by J. Strüver, "Die fossilen Fische aus dem Obern Keupersandstein von Coburg." Zeitschr. deutsch. Geol. Ges., 1864, Vol. xvi, pp. 322–329, Pl. xiii, fig. 2.

|| *D. superstes*: *Palæoniscus superstes*, Egerton, Quart. Journ. Geol. Soc., 1858, Vol. xiv, p. 164, Pl. xi.

General Form.—The trunk is slender, and the head, with the opercular apparatus (if completely preserved in No. *b*), occupies less than one-fourth the total length of the fish. The dorsal fin appears precisely opposite the anal, and approximately equal to it in size; and the caudal fin is deeply forked.

Head and Opercular Apparatus.—The snout is obtuse, the eye large, and the mandible apparently slender. It may also be noted that some, at least, of the head bones are ornamented by superficial striæ; but nothing further can be observed of the structure of these parts.

Appendicular Skeleton.—In all the fins the rays are robust, but very closely arranged, and bifurcating distally, and small fulcra are prominent on the anterior margin of each. In No. *d*, the pectorals have relatively long rays, extending more than half the distance to the pelvic pair. The latter, well shown in Pl. IV, Fig. 6, are powerful, consisting of at least eight or nine distally-bifurcating rays; and there are four slender basal fulcra in front, passing downwards into the small fuleral fringe of the first ray. The dorsal and anal fins are nearly equal and opposite, suggesting the specific name of the fish; but the number of rays is greatest, as usual, in the anal, being here about sixteen or twenty. The anterior fulcra (Pl. IV, Fig. 5*a*) are similar to those of the pelvic fins.

Squamation.—The scales are ornamented with faint oblique ridges or grooves, and the narrowing of the ventral series is very conspicuous in all the specimens. In No. *c*, the scales of the anterior portion of the flank are somewhat deeper than broad; and each appears to have an inner vertical keel, mesially placed.

Remarks.—In the position of the dorsal fin, and in general proportions, this species closely resembles *D. macrura*, *D. superstes*, and *D. socialis*. It differs from the first in its smaller size, and both from this and the second in the presence of ornamentation upon the scales; it is also distinguished from *D. socialis* by its smaller size and the less robust character of the caudal pedicle.

DICTYOPYGE ILLUSTRANS, *sp. nov.*

Pl. IV, Figs. 7–9.

Obs.—The most abundant and best preserved species is somewhat larger than the foregoing, and may be appropriately named *D. illustrans*, in allusion to its possession of certain features probably destined to shed new light upon the precise affinities of the genus. Five specimens exhibit its principal characters:—

(*a*) Type-specimen (Pl. IV, Fig. 7).
(*b*) A more imperfect fish, partly distorted (Pl. IV, Fig. 8).
(*c*) Another example, of similar size and proportions, in counterpart.
(*d*) A fish with the well-preserved tail shown, of twice the natural size (Pl. IV, Fig. 9.)
(*e*) An imperfect small specimen, 0·058 in length, in counterpart.

General Form.—The general form and proportions of the fish are well shown in the type-specimen (Pl. IV, Fig. 7). The trunk is relatively short and stout, the head, with the opercular apparatus, occupying almost a quarter of the total length, and the gape of the mouth is very wide. The dorsal fin is for the most part in advance of the anal; the upper lobe of the tail is conspicuously produced, and the caudal fin powerful (Pl. IV, Fig. 9).

Head and Opercular Apparatus.—Little can be discerned of the structure of the head, but in the type-specimen and No. *b* (Pl. IV, Figs. 7, 8), the forward position of the eye, and the obliquity of the mandibular suspensorium, are evident; and both in the first and other specimens there seem to be traces of minute conical teeth upon the margins of the jaws. The impression of an antero-posteriorly elongated bone upon the cheek is distinct (Pl. IV, Fig. 7, *x*), but indeterminable; and the external surface of all the elements is probably ornamented with fine striæ and tuberculations (No. *e*). The operculum (*op.*) and suboperculum (*s. op.*) are narrow; and, unless appearances are deceptive in the type, the former is much smaller than the latter.

Appendicular Skeleton.—The clavicle and supraclavicle are well shown in the type-specimen, the external striated surface of the former being narrower than that of the latter; and in the same fossil, immediately below the posterior portion of the mandible, an antero-posteriorly elongated triangular area is worthy of note. This feature, with a sharply-pointed anterior extremity and longitudinal mesial elevation, and, possibly, superficial rugæ, may well be interpreted as an infraclavicular element, though further evidence must be awaited before the determination can be affirmed as a fact.

Of the paired fins, the pectorals are indicated in No. *b* (Pl. IV, Fig. 8) by a few powerful rays; and in the same fossil the smaller pelvic fins apparently exhibit a long base-line. The dorsal and anal fins are elevated and triangular in form, and the first is placed almost entirely in advance of the second; the dorsal is also conspicuously smaller than the anal, the one, in the type-specimen, exhibiting about twenty rays, while the other has not less than twenty-eight. The basal fulcra are long and slender, passing upwards into the fine fulcral fringe upon the first ray, exactly as figured by Egerton in *D. superstes.** The caudal fin is well shown, of twice the natural size, in Pl. IV, Fig. 9; it is robust and moderately forked. The rays are closely apposed and finely jointed, and there are distinct fulcra above and below.

Squamation.—The scales of the flank are at least as deep as broad, while those of the ventral series are twice as broad as deep. They are best seen in the type-specimen, and the posterior two-thirds of the surface of each is ornamented with sparse oblique markings, which may have originally been either grooves or ridges. In some of the flank-scales (Pl. IV, Fig. 7*a*), two of these markings are observed; in a few placed most anteriorly, there are perhaps three, sometimes wavy. The ventral scales (Pl. IV, Fig. 7*b*) have mostly only one such superficial mark. The small diamond-shaped scales upon the upper lobe of the tail have a single diagonal ridge or furrow, inclined forwards and downwards; and upon the superior margin of this short pointed lobe are a series of very large fulcral scales, passing upwards into the small fulcral fringe upon the edge of the fin.

Remarks.—*D. illustrans* differs from all known species except *D. catopterus* in the comparatively forward position of the dorsal fin; and it is readily distinguished from this species by the greater depth of the trunk and the smaller dimensions of the caudal fin.

DICTYOPYGE ROBUSTA, *sp. nov.*

Pl. III, Figs. 4, 5.

A very robust species referable to *Dictyopyge*, as here defined, is indicated by a few imperfectly preserved specimens, of which the following are characteristic:—

(*a*) Type-specimen (Pl. III, Fig. 4).

* Quart. Journ. Geol. Soc., Vol. xiv, Pl. xi, fig. 3.

(*b*) A nearly complete trunk, with pelvic, dorsal, anal, and caudal fins.

(*c*) A more imperfect trunk, with portions of the median fins, shown in Pl. III, Fig. 5.

(*d*) Head and trunk, wanting the tail.

(*e*) Nearly complete fish, wanting the pectoral, dorsal, and anal fins.

General Form.—The trunk is comparatively deep in the abdominal region, and the dorsal contour more arched than is usual in *Dictyopyge.* The head, with the opercular apparatus, occupies about one-quarter of the total length of the fish; and the snout seems to have been bluntly pointed. The dorsal and anal fins are long, and the former is placed partly in advance of the latter. The upper lobe of the tail is conspicuously produced.

Head and Opercular Apparatus.—None of the bony elements of the head and opercular apparatus can be distinguished, and only faint impressions of circumorbital bones exhibit the position and proportions of the eye. The mouth is large and deeply cleft, as usual, and in Nos. *d* and *e* appearances are suggestive of small, stout, conical teeth, placed in close series in the upper jaw. Some irregular superficial striæ are seen in No. *e*.

Appendicular Skeleton.—A gently arched, slender clavicle, with part of a more expanded supraclavicle, is shown in Pl. III, Fig. 5; and both of these elements exhibit superficial longitudinal striations. The pectoral fin, however, is not distinct in any specimen. The pelvic fins are of moderate size, each consisting of about seven rays, and placed nearer to the anal than to the pectorals. The dorsal and anal fins are both elongate, and of about equal size, the latter commencing at a point nearly opposite the middle of the former. In the type-specimens distinct fulcra are observed upon the anal fin, and the number of rays is about thirty, generally shortening and more widely spaced posteriorly. The caudal fin (No. *e*) is broad, powerful, and deeply forked.

Squamation.—Though always indistinct, the scales appear to have been superficially ornamented with a few short oblique ridges or furrows. Those upon the flank are at least as deep as broad, while those upon the ventral aspect are conspicuously broader than deep; and the scales upon the caudal pedicle are not excessively elongated. Appearances in some specimens are also suggestive, at first sight, of the presence of a series of dorsal ridge-scales;

but a careful examination of the fossils, and comparison with the examples of *Pristisomus*, which undoubtedly possess such scales, seem to demonstrate that in the species under discussion the markings are deceptive, and due to accident in preservation.

Remarks.—This species can only be compared with *D. illustrans*, from which it differs in the more robust proportions of the trunk, and the greater extent of the dorsal and anal fins.

(iii)—Caudal fin diphycercal.

Family.—BELONORHYNCHIDÆ.

Fam. Char.—Body long and slender; snout much elongated and pointed; notochord persistent, the bases of the arches expanded; paired fins moderately developed; dorsal and anal fins large, nearly equal, and opposite, very remote; caudal fin distinct, symmetrical, fan-shaped; fulcra minute or absent. No continuous squamation, but sometimes, at least, isolated longitudinal series of dermal scutes.

Obs.—The typical genus of this family *(Belonorhynchus)* has hitherto been compared with the Ganoid *Belonostomus** and the Teleostean *Belone* and *Fistularia*,† while Lütken ‡ and Zittel § have ventured to assign it a place in the peculiar Cretaceous family of Hoplopleuridæ. The Hawkesbury fossils described below, however, demonstrate that all these conclusions are founded upon imperfect evidence; and the fish truly occupies a much lower position in the zoological scale than at present supposed.

Particularly noteworthy, for example, are the dorsal and anal fins, in which the interspinous bones are much fewer in number than the dermal rays they support (Pl. IX, Figs. 3, 4; Pl. X, Fig. 2)—a primitive character never retained in such specialized groups as the "Lepidosteoidei" and the Teleostei. Appearances are also suggestive of the presence of a series of cartilages at the base of the pelvic fins (Pl. IX, Fig. 3; Pl. X, Fig. 4), though the point is not actually proved; and one example of *B. striolatus* in the British Museum (P. 966) exhibits a pair of triangular bones in front

* H. G. Bronn, "Beiträge zur triasischen Fauna und Flora der bituminösen Schiefer von Raibl," Neues Jahrb., 1858, p. 12. Also Smith Woodward, "Note on the Early Mesozoic Ganoid, *Belonorhynchus*," Ann. Mag. Nat. Hist., 1888, [6] Vol. i, p. 356.

† R. Kner, "Die Fische der bituminösen Schiefer von Raibl in Kärnthen," Sitzungsb. math.-naturw. Cl. k. Akad. Wiss., Vol. liii, Pt. i, 1866, pp. 189–196, Pl. vi.

‡ C. F. Lütken, "Professor Kner's Classification of the Ganoids," Geol. Mag., 1868, Vol. v, p. 432.

§ K. A. von Zittel, Handbuch der Palæontologie, 1888, Vol. iii, p. 265.

of the pectoral fins, which may possibly be interpreted as infraclaviculars. Moreover, there is not the slightest trace of ossification in the sheath of the notochord; and Prof. Cope regards this character in Ganoids as a mark of very low degree.*

It is also generally admitted that the Triassic and Rhætic *Saurichthys* is closely related to *Belonorhynchus*, being referable to the same family. Such being the case, the recent discovery of the maxilla of *Saurichthys* makes known another singular feature, hitherto only observed in one of the Crossopterygian Ganoids *(Polypterus)*, *i.e.*, the presence of a considerable maxillary palatal extension.†

Genus—BELONORHYNCHUS, *Bronn*, 1858.

(Neues Jahrbuch, 1858, p. 7.)

Ichthyorhynchus, C. Bellotti, in C. Stoppani, Studii Geol. e Pal. Lombardia, 1857, p. 436.

Gen. Char.—Upper and lower jaws approximately equal in length, provided with few large conical teeth, and a close series of similar but smaller teeth; mandible very deep posteriorly. Head and opecular bones superficially ornamented with striations. Trunk with four longitudinal series of dermal scutes, one dorsal and another ventral, and one smaller pair laterally placed, supporting the "lateral line."

Belonorhynchus gigas, *sp. nov.*

Pl. IX, Figs. 1, 2; Pl. X, Figs. 1, 2.

Obs.—Seven specimens, in various states of preservation, exhibit all the most characteristic features of a large species of *Belonorhynchus* attaining a length of at least 0·49, and probably sometimes much more. The series comprises :—

(*a*) A nearly complete fish with imperfect fins, the pectorals being absent, the anal much broken, and the dorsal destroyed. This is the type-specimen and is shown of six-sevenths the natural size in Pl. IX, Fig. 1.

(*b*) Imperfect skull and mandible (Pl. X, Fig. 1).

(*c*) A smaller fragment of skull and mandible.

* E. D. Cope, Review in Amer. Naturalist, 1887, p. 1018.

† Smith Woodward, "On a Maxilla of *Saurichthys* from the Rhætic of Aust Cliff, near Bristol," Ann. Mag. Nat. Hist., 1889, [6] Vol. iii, pp. 301, 302, Pl. xiv, figs. 7, 8.

(*d*) The greater portion of the trunk in a good state of preservation (Pl. IX, Fig. 2), with the dorsal, anal, and right pelvic fins, but with an imperfect caudal.

(*e*) Fragment of the middle portion of the trunk, with the left pelvic fin.

(*f*) Portion of a very large trunk, probably of this species, showing the dorsal and anal fins (Pl. X, Fig. 2).

(*g*) Imperfect caudal fin, showing articulated rays (Pl. VIII, Fig. 6).

General Form.—Though not exhibiting many details, the type-specimen (Pl. IX, Fig. 1), shows the general proportions of the fish; and the characters of some of the imperfect parts are displayed in other examples. The entire head, including the opercular bones, is about half as long as the trunk; and the body does not taper until the commencement of the dorsal and anal fins, in some cases, indeed, having the appearance of deepening a little at the latter point. The caudal pedicle is very narrow and short, tapering, and fringed with the caudal fin in the usual manner. The absence of the pectoral fins in the type-specimen suggests that they were small and delicate; and the pelvic fins are moderately powerful, and situated nearer to the anal than to the pectorals.

Head and Opercular Bones.—As shown both in the type-specimen and in No. *b* (Pl. X, Fig. 1), the skull rapidly tapers in front of the orbit, and is prolonged into a very slender snout; the alveolar border is nearly straight; and the orbit and nasal opening, though not distinctly shown, are doubtless similar in form, situation, and proportions to the corresponding apertures in the European species of *Belonorhynchus*. The mandible apparently equals the skull in depth, and, when crushed, is nearly similar to it in profile-outline. Both skull and mandible are externally ornamented by delicate ridges or striations, those upon the cranial roof being somewhat irregular and confused, but those along the sides of the skull becoming parallel, vertically directed, and passing into transverse markings upon the snout; those upon the hinder portion of the mandible (No. *c*) exhibit a tendency towards an irregular pattern.

The dentition (Pl. X, Fig. 1), is very powerful and apparently similar in both jaws. A widely-spaced series of very large conical teeth, with delicate superficial striations, is placed above and below, at least in the anterior half of the mouth; and between these teeth are several smaller cones attaining only about one-half their height, but otherwise of a very similar character. It is also probable that outside this dentition, a row of very small teeth occupies the extreme margin; for in No. *c* such a series is to be seen, and its components are too small to be considered equivalent to the lesser teeth of No. *b*. All the teeth are destitute of complete sockets, and are anchylosed to the bone.

The opercular bones are not distinctly shown, but in the type-specimen there are indications of an operculum corresponding in shape and size to that of the typical *B. striolatus* from Raibl.

Axial Skeleton of Trunk.—In every example of the trunk, there is a well-marked vacant space between the opposed series of neural and hæmal arches; and it may, therefore, be inferred that the notochord was persistent. In some cases, moreover, as in the originals of Pl. IX, Figs. 1, 2, the space between the two sets of arches has been much increased by crushing—a circumstance suggestive of the same conclusion. In the type-specimen the respective lengths of the abdominal and caudal regions are about 0·18 and 0·145; and the pelvic fins are placed nearly at the hindermost extremity of the former. In both regions, the neural arches (Pl. X, Fig. 2, *n*) are all expanded, and each neural spine is broad at its base, gradually tapering to a pointed distal extremity. In the caudal region, the hæmal arches and spines (Pl. X, Fig. 2, *h*) are also similar to these, and exhibit complete symmetry with those neurals opposed to them In the abdominal region, a series of robust, nearly straight ribs is conspicuous, giving to imperfect specimens the false appearance of a covering of deep lateral scales, like those characterizing the genus *Belonostomus*. The type-specimen (Pl. IX, Fig. 1) exhibits the ribs of the left side to the number of at least nineteen, and it is not improbable that these were succeeded by others too little ossified to be preserved. Each rib is expanded at its proximal extremity, the successive expansions doubtlessly being more or less connected one with another; and this affords an explanation of their regular linear arrangement even when displaced.

Appendicular Skeleton.—The paired fins have already been referred to—the pectorals as probably small and delicate, the pelvics as being of considerable size and placed near the hinder extremity of the abdominal region. The latter are also remarkable for the length of their base-line. There is no trace of the basal ("pelvic") bone, but the fin-rays are at least sixteen in number (Pl. IX, Fig. 2), and each is comparatively broad and flattened. The few most preaxial rays rapidly lengthen to the longest, those behind gradually shortening; and although each is divided by a few distant transverse joints, there is apparently no distal bifurcation.

Of the median fins, the dorsal and anal are well shown in the original of Pl. IX, Fig. 2, and also in the large specimen No. *f* (Pl. X, Figs. 2, *a*, and *d*). In the first-mentioned fossil, each fin is nearly equal in maximum depth to the breadth of the trunk at the commencement of its insertion; and the anterior margin gradually slopes backwards to the summit of the fin, whence the height diminishes behind, finally ending abruptly with the small terminal ray. Both fins are supported by a series of robust interspinous bones, much fewer than the fin-rays; and three or four of these endoskeletal elements appear to be free in advance of the dermal structures (Pl. P, Fig. 2, *in*). All the interspinous bones, as well as the neural and hæmal arches are only superficially ossified, and the soft internal cartilage is sometimes replaced by calcite, while in other cases there is no infilling, and the part has consequently become crushed or split. The fin-rays are slightly more than fifty in number in the dorsal fin, and at least fifty in the anal; they are broad and flattened, longitudinally ribbed, and closely placed proximally, though slightly diverging distally; and all are divided by several widely-spaced transverse joints, though only the hinder rays tend to branch towards the extremities. The anterior margin of both these fins and the caudal is formed by the pointed extremities of the successively lengthening rays; and there are no traces of fulcra, except in the dorsal of No. *f* (Pl. X, Figs. 2, *d*), where some minute points may perhaps be interpreted as such. The caudal fin-rays are articulated and bifurcate distally (Pl. VIII, Fig. 6), and the fin is either very slightly excavated in the middle or not forked (Pl. IX, Fig. 1).

Exoskeleton of Trunk.—The four longitudinal series of dermal scutes characteristic of the genus *Belonorhynchus*, are especially well shown in the original of Pl. IX, Fig. 2. The scutes of the median dorsal and ventral series are approximately of the same size, and relatively the largest upon the caudal pedicle; but those of the lateral line are very much smaller, being only about one-half the dimensions. The dorsal and ventral scutes are at least twice as broad as long, and bi-laterally symmetrical; and the anterior margin exhibits a wide re-entering angle, while the posterior margin has a corresponding ∠-shaped projection, thus rendering the two borders almost parallel. The lateral borders of each scute are straight, and also parallel or slightly diverging posteriorly; and the external surface is marked by a prominent tubercular ornamentation, in addition to an occasional slight median longitudinal keel. The scutes of the lateral line, though of smaller size, appear to be of a very similar form, only differing in their more keeled character, due to the presence of the longitudinal perforation; and the latter is well shown in the fossil by the infiltration of a conspicuous white thread of calcite.

Remarks.—*B. gigas* may be distinguished from all known species of the genus by the relative breadth of the dorsal and ventral scutes. In size, it is almost equalled by *B. acutus** and *B. macrocephalus*,† and in the relative proportions of the head and trunk it is closely paralleled by the latter species; but *B. acutus* possesses spine-shaped dorsal scutes (Pl. VIII, Fig. 7), and in *B. macrocephalus* these defences are not much broader.

It is interesting to add that evidence of a still larger species of *Belonorhynchus* occurs in the Keuper of Seefeld, Tyrol, a crushed skull (as pointed out by Zittel‡) being described by Kner§ under the name of *Teleosaurus tenuistriatus*.

Belonorhynchus gracilis, *sp. nov.*

Pl. VIII, Fig. 5; Pl. IX, Figs. 3, 4; Pl. X, Figs. 3, 4.

Obs.—A second species of *Belonorhynchus* is indicated by a fish of much more slender and delicate porportions than *B. gigas*, and usually smaller. Its character can be very completely ascertained from the following series of specimens :—

(*a*) A nearly complete head and trunk, seen from the ventral aspect, wanting all the fins except portions of the anal and caudal. This is the type-specimen shown of the natural size in Pl. VIII, Fig. 5.

(*b*) Detached head, side view (Pl. X, Fig. 3).

(*c*) The greater portion of the trunk, side view, with imperfect pelvic and median fins.

(*d*) The greater portion of the trunk, side view (Pl. IX, Fig. 3).

(*e*) Hinder portion of the trunk, showing fins (Pl. IX, Fig. 4).

* *Belonostomus acutus*, L. Agassiz, Rech. Poiss. Foss., 1843, Vol. ii, Pt. ii p. 142, Pl. xlvii *a*, figs. 3, 4. Assigned to *Belonorhynchus* by K. A. von Zittel, Handbuch Palæontologie, Vol. iii, p. 222.

† W. Deecke, "Fische aus den schwarzen Schiefern von Perledo," Palæontographica, 1889, Vol. xxxv, pp. 127-131, Pl. viii, figs. 1, 2.

‡ K. A. von Zittel, Handbuch Palæontologie, Vol. iii, p. 266.

§ R. Kner, "Nachtrag zur fossilen Fauna der Asphaltschiefer von Seefeld in Tirol," Sitzungsb. math.-natur. Cl. k. Akad. Wiss., 1867, Vol. lvi, Pt. i, pp. 905-909, Pl. iii.

(*f*) Portion of the trunk, exhibiting both pelvic fins and a fragment of the pectoral, preserved in counterpart.

(*g*) Portion of the trunk, with a fragment of the left pelvic fin, and the bases of the dorsal and anal.

(*h*) Fragment of large trunk, with pelvic fin (Pl. X, Fig. 4).

General Form.—As shown by the type-specimen (Pl. VIII, Fig. 5), the trunk is very long and slender, its length being at least three times as great as the total length of the head and opercular bones. As in *B. gigas* there is sometimes an indication of a slight deepening of the trunk at the commencement of the dorsal and anal fins, though this, again, may perhaps be due to crushing during fossilization. As in *B. gigas*, also, the pectoral fins appear to have been small and delicate.

Head and Opercular Bones.—The head is shown from beneath in Pl. VIII, Fig. 5, and from the lateral aspect in Pl. X, Fig. 3. The side of the skull is superficially ornamented by fine vertically directed ridges or striations, like those of *B. striolatus* and *B. gigas;* and the mandible is also marked by similar striations, curved upwards behind, but mainly extending in the direction of its long axis. Nothing noteworthy can be observed in the characters of the skull or opercular apparatus; but in the type-specimen the mandible is fractured in such a manner as to suggest the presence of an elongated anterior azygous element (Pl. VIII, Fig 5, *ps.*), similar to that already supposed to be a presymphysial bone in the *B. acutus* of the English Lias.* The teeth are imperfectly displayed, and exhibit the usual characteristics.

Axial Skeleton of Trunk.—In every respect the known specimens of *B. gracilis* agree with those of *B. gigas* already described, in demonstrating the persistence of the notochord and the expansion of the bases of the neural and hæmal arches. These fossils, moreover, correspond in showing that the endoskeletal parts were only superficially calcified or ossified; and in some cases the crushing during fossilization seems to have produced a false appearance of striation upon the matrix where the obscure remains occur. Strong ribs are seen in the type-specimen (Pl. VIII, Fig. 5, *r*), arranged in about twenty pairs.

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* Smith Woodward, "On the Mandible of *Belonostomus cinctus*," Quart. Journ. Geol. Soc., 1888, Vol. xliv, p. 147, Pl. vii, fig. 14.

Appendicular Skeleton.—Of the paired fins, the pelvics appear to have been the most powerful, and the pectorals are only represented in one specimen (No. *f*) by an imperfect fragment. As shown by No. *c*, each pelvic fin consists of at least twenty stiff rays, articulated at distant intervals; and, if this specimen is not deceptive, the appendage has a gently rounded free margin, the rays gradually diminishing in length both in front and behind (Pl. IX, Fig. 3, and Pl. X, Fig. 4). It is also, perhaps, noteworthy that in the originals of Pl. IX, Fig. 3, and Pl. X, Fig. 4, there is a considerable vacant space between the base of the dermal rays and the trunk.

The median fins are rarely well preserved, but, so far as known, they differ little in form and proportions from those of *B. gigas.* The large interspinous bones supporting the dorsal and anal fins are well shown in the originals of Pl. IX, Figs. 3 and 4, where they, perhaps, correspond in number with the neural and hæmal spines, but are much fewer than the fin-rays; the latter are at least fifty in number in the dorsal fin, and they are all much flattened, apparently articulated though not branching, and closely arranged.

Exoskeleton of Trunk.—Like the other species of the genus, *B. gracilis* possesses four longitudinal series of dermal scutes—a median dorsal and a median ventral of equal size, and a row of smaller scutes on each side supporting the canal of the lateral line. Each of the dorsal and ventral scutes (Pl. VIII, Figs. 5, *d.s.*, *v.s.;* Pl. IX. Figs. 3 and 4; Pl. X, Fig. 4) is longer than broad, the anterior margin having a deep triangular excavation, and the posterior margin being acutely pointed, though somewhat rounded laterally. The anterior border of one scute is overlapped, as usual, by the posterior border of the one immediately in front; and the external surface of each evidently exhibits a low longitudinal keel, though traces of superficial tuberculations are only discernible in one specimen, No. *g*. It is also interesting to observe that in one fossil (Pl. X, Fig. 4) there is an appearance of bifurcation of the ventral series of scutes in the region of the pelvic fins, resembling the loop-arrangement surrounding the "anal-grube" in *B. striolatus* (Pl. X, Fig. 5) already made known by Kner.*

Remarks.—This species is distinguished from its nearest known allies, *B. gigas* and *B. macrocephalus*, by the form of the scutes and the relatively greater elongation of the trunk.

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* R. Kner, Sitzungsb. math.-natur. Cl. k. Akad. Wiss., 1866, Vol. liii, Pt. i, p. 194, Pl. vi, fig. *f*. The present Writer has been able to confirm this determination by an examination of the original specimens in the Geol. Reichsanstalt at Vienna.

B. Ganoids, in which the dorsal and hæmal interspinous bones are equal in number to the opposed dermal fin-rays.

Family—SEMIONOTIDÆ.

Fam. Char.—Body fusiform or deep, with enamelled rhombic scales; head with well-developed membrane-bones, externally enamelled; mouth small, and teeth conical or styliform. Upper lobe of tail very slightly produced. Fin-fulcra usually prominent.

Genus—SEMIONOTUS, *Agassiz*, 1843.

Semionotus, Agassiz, Rech. Poiss. Foss., 1843, Vol. ii, Pt. i, p. 222.
Ischypterus, Egerton, Quart. Journ. Geol. Soc., 1847, Vol. iii, 1847, p. 277.

Gen. Char.—Body elegantly fusiform; scales of the flank not more than twice as deep as broad, those of the ventral aspect equilateral or broader than deep; dorsal ridge-scales present, but no ventral series. Teeth small, conical, and somewhat spaced. Paired fins moderately developed; dorsal fin very large, arising near the middle of the back and partly opposed to the small anal; caudal fin large, scarcely forked. Fulcra prominent upon all the fins.

Obs.—The scientific definition of this genus has only become precise through the gradual progress of research since Agassiz's original description. For, as pointed out by Prof. Oscar Fraas,* the type-species, *S. leptocephalus*, does not pertain to the same genus as the best preserved of the other specimens described under the name of *Semionotus;* and it appears certain that the original example of the species just mentioned belongs to the genus *Pholidophorus*.† The second Agassizian species, *S. Bergeri*, is thus commonly regarded as the type; and the American Triassic fishes, named *Ischypterus* by Egerton, only differ from this form in the slightly greater development of the fin-fulcra—a feature of not more than specific value.

The genus is essentially characteristic of early Mesozoic times—notably of the Trias and Rhætic; and most of the species assigned to *Semionotus* from the Lias and later deposits are erroneously determined.

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* O. Fraas, "Ueber *Semionotus*," Wurtt. Jahresh., 1861, Vol. xvii, p. 85.

† Smith Woodward, "Vertebrate Palæontology in some Continental Museums," Geol. Mag. [3] 1888, Vol. v, p. 401.

Semionotus australis, *sp. nov.*

Pl. VI, Fig. 2.

Obs.—A single imperfect specimen, wanting the head and anterior portion of the trunk, seems to pertain to a typical species of *Semionotus*, and is shown of the natural size.

General Form.—The trunk is as deep as in the most typical members of the genus, the maximum depth being probably contained not more than three-and-a-half times in the total length; and the tail exhibits the usual robust proportions. The dorsal fin is distinctly larger than the anal, though scarcely so well-developed; and this arises opposite a point immediately behind the insertion of the pelvic fins.

Appendicular Skeleton.—Of the paired fins, only the pelvics are preserved, these being small and consisting of not less than four elongated rays. The dorsal fin is evidently in part destroyed behind, but exhibits fifteen rays between its origin and a point opposite the origin of the anal; while the latter fin, so far as preserved, consists of nine well-separated rays. Fulcra are distinct upon the anterior margin of each of the fins, though relatively small and stout, except at the base of the dorsal and caudal; and all the fin-rays are of the ordinary robust, articulated, and distally-bifurcating type.

Squamation.—The scales of the anterior portion of the flank are notably deep, many being twice as deep as broad; and the lateral line was evidently well-marked, though the state of preservation of the fossil, exhibiting the lateral line of both sides, does not permit of its precise course being traced. The dorsal ridge-scales are destroyed.

Remarks.—In the form of the trunk, this species most nearly approaches *S. Bergeri*,* but is readily distinguished by the smaller fin-fulcra, the less extent of the dorsal fin, and by the depth of the principal flank-scales. In the last-named feature it also appears to differ from all other described species, except *S. Nilssoni*,† and this is characterized by a much deeper trunk.

Semionotus tenuis, *sp. nov.*

Pl. VI, Fig. 3.

Obs.—A second well-marked species of *Semionotus* occurs in the Hawkesbury beds, as indicated by two imperfectly preserved examples, of which one is shown of the natural size.

* See especially J. Strüver, Zeitsch. deutsch. geol. Ges., 1864, Vol. xvi, pp. 303–321, Pl. xiii, figs. 1, 3, 4.
† L. Agassiz, Rech. Poiss. Foss., 1843, Vol. ii, Pt. i, p. 229, Pl. xxvii *a*, figs. 1–5.

General Form.—The body is remarkably elongated, the maximum depth being contained more than four times in the total length. The head and opercular apparatus occupy about one-fourth of the total length; and the dorsal fin is very high, the length of the anterior ray almost equalling the depth of the trunk at its point of insertion.

Appendicular Skeleton.—The pectoral fins are placed well above the inferior margin of the flank, the remains of about six or eight rays of one fin being distinguishable in the type-specimen. The pelvic fins in each fossil are unfortunately destroyed; and only the anterior margin of the dorsal is preserved. Very little of the latter is seen in the type-specimen, but the anterior ray seems to be unbroken in the second example under discussion, and the dimensions of the fin thus indicated are shown by the dotted line (Pl. VI., Fig. 3). The anal fin is evidently opposed to the hinder portion of the dorsal, and its anterior rays are also much elongated, their length being equal to the depth of the caudal region at their point of insertion. The caudal fin is of the usual proportions, and consists of more than twenty bifurcating rays. The fulcra upon the anterior margin of each of the median fins are large and conspicuous, but remarkably slender.

Squamation.—As in *S. australis* described above, the scales of the middle of the anterior portion of the flank are twice as deep as broad; and at the extremity of the caudal pedicle, small diamond-shaped scales distinctly cover an abbreviated upper lobe.

Remarks.—This species is distinguished by the elongation of the body, the depth of the flank-scales, and the extreme tenuity of the large fin-fulcra. In the relative length and slenderness of the trunk, it is only equalled by *S. elongatus*,* from the Keuper of Stuttgart, and this species differs considerably in the characters of its squamation.

Genus PRISTISOMUS, *gen. nov.*

Gen. Char.—Body comparatively deep, but fusiform; three or more series of the flank-scales vertically elongated; a dorsal and ventral series of prominent ridge-scales. Teeth large, styliform, in close series. Paired fins moderately developed; dorsal and anal fins remote, the former partly opposed to the latter; caudal fin robust, scarcely forked. Small fulcra present upon all the fins.

* O. Fraas, "Ueber *Semionotus*," Württ. Jahresh., 1861, Vol. xvii, pp. 93, 95, Pl. 1, figs. 4, 5.

Obs.—This is an interesting genus, most nearly related to *Semionotus* and *Dapedius*, and in some respects intermediate between these two forms. The long styliform teeth, and certain obscurely recognizable features in the head, are most suggestive of *Dapedius*; and the depth of the trunk nearly approaches that of some of the species of the last-named genus. The dorsal ridge-scales, however, and the proportions of the median fins, more resemble corresponding features in *Semionotus;* though this well-known genus is distinguished by its dentition, the absence of ventral ridge-scales, the slight vertical elongation of the flank-scales, and the greater development and more forward position of the dorsal fin.

In the vertical elongation of the flank-scales, *Pristisomus* may also be compared with a Liassic genus, *Nothosomus*, described by Egerton;* but in every other known feature of importance these two generic types are distinct.

PRISTISOMUS GRACILIS, *sp. nov.*

Pl. V, Fig. 1; Pl. VI, Fig. 1; Pl. VIII, Fig. 1.

Obs.—The typical species, *P. gracilis*, is so well represented by a single complete trunk, that only two other specimens need be referred to for the determination of the characters of the head, while a third exhibits the dorsal and anal fins in unusual completeness. These fossils may be enumerated thus:—

(*a*) Type-specimen, shown of the natural size in Pl. V, Fig 1.

(*b*) Somewhat more slender fish, exhibiting the head, but wanting the paired fins.

(*c*) An imperfect specimen, showing part of the head and opercular apparatus (Pl. VI, Fig. 1).

(*d*) An imperfect specimen with well-preserved median fins (Pl. VIII, Fig. 1).

General Form.—The trunk is gracefully fusiform, the maximum depth being contained more than two-and-a-half times in the total length. The head is triangular and the snout pointed, and the distance from the extremity of the snout to the posterior margin of the operculum is not more that one-quarter of the total length. The dorsal and anal fins are almost of equal size, with a short base-line and much elevated.

* "Figs. and Descrip. Brit. Org. Remains," Mem. Geol. Survey, Gt. Brit., 1858, Dec. ix, No. 6.

Head and Opercular Apparatus.—The proportions of the head and opercular apparatus are shown in No. *b*, but the only example exhibiting the faintest details of structure is the imperfect specimen, No. *c* (Pl. VI, Fig. 1). The roof of the skull is extended by membrane bones well over the operculum; the orbit is large, and the two postero-superior elements of the well-developed sub-orbital ring are evident. The preoperculum appears to have been absent, and the operculum and suboperculum have a short antero-posterior measurement; the precise position of the suture between the two latter elements is uncertain, though it is probably the lower of the two transverse lines indicated in the figure.

Appendicular Skeleton.—Portions of the paired fins are preserved in the type-specimen (Pl. V, Fig 1), both exhibiting much elongated slender rays; and the pelvic fins are placed much behind a point half-way between the opercular apparatus and the anal fin. As just mentioned, the dorsal and anal fins (Pl. V, Fig. 1; Pl. VIII, Fig. 1) are almost equal in size, and the former arises slightly in advance of the latter; the length of the longest rays in the anal is greater than the extent of the base-line, while in the dorsal the same is almost the case; and in the first-mentioned fin there are twelve or thirteen rays, while in the dorsal this number is only exceeded by one or two. The caudal fin is beautifully preserved and slightly forked, consisting of about sixteen to twenty rays; and its upper and lower margins, like the anterior margins of the dorsal and anal, are fringed with delicate fulcra. The fin-rays are well spaced, and in all the fins they appear to be closely articulated and soon bifurcating.

Squamation.—The scales of two series upon the middle of the anterior portion of the flank are in part four times as deep as broad, and, as shown by No. *c* (Pl. VI, Fig. 1), the lateral line traverses the uppermost of these, dividing each scale unequally in the ordinary manner. Above and below the two principal series just mentioned, the scales are much deeper than broad in two other series, and it is only towards the extremity of the caudal region that they appear to become equilateral. The sharply-pointed dorsal and ventral ridge-scales are also distinctly recognizable.

Remarks.—From the species described below, *P. gracilis* is distinguished by its more slender proportions, and the great elevation of the dorsal and anal fins.

Pristisomus latus, *sp. nov.*

Pl. V, Figs. 2, 4.

Obs.—Several specimens indicate the occurrence of a comparatively deep-bodied species of *Pristisomus,* and the following three may be selected for special notice :—

(*a*) The type-specimen, wanting the caudal pedicle and fin, shown of the natural size in Pl. V, Fig. 2.

(*b*) A more imperfectly preserved fish, wanting the head and paired fins (Pl. V, Fig. 3).

(*c*) Imperfect fish, with well-displayed pectoral fin (Pl. V, Fig. 4).

General Form.—The trunk is comparatively high, the maximum depth being contained only two and a half times, or less, in the total length. The head is triangular and the snout pointed, and the distance from the extremity of the snout to the posterior margin of the operculum is contained slightly more than four times in the total length. The dorsal fin is considerably longer than the anal and not remarkably elevated, and the caudal fin is apparently small.

Head and Opercular Apparatus.—In the type-specimen (Pl. V, Fig. 2) the dentary bone is seen to be robust, and the close array of styliform teeth is displayed ; but no other details are recognizable, nor is any other specimen more satisfactory.

Appendicular Skeleton.—The paired fins are placed well upon the sides of the trunk ; each of the pectorals exhibiting not less than nine robust rays of considerable length (Pl. V, Fig. 4), and the pelvics being much smaller, with at least six rays in the type-specimen. The pelvic pair is placed nearer to the anal than to the insertion of the pectoral pair ; and the dorsal and anal are opposed in the ordinary manner. The dorsal fin exhibits seventeen rays in the type-specimen, and the length of the longest is much less than that of the base-line. The anal fin, which appears to be complete in No. *b* (Pl. V, Fig 3) is more elevated than the dorsal, comprising about fourteen rays ; but its longest ray scarcely exceeds the length of its base-line. The caudal fin, if complete in No. *b* (Pl. V, Fig. 3), is relatively small, exhibiting twenty-two rays ; and the anterior margins both of this and the other median fins are provided with prominent fulcra, with a few of especially large size at the base. A few interspinous bones in the anal of No. *b* are seen to correspond in number with the opposed fin-rays.

Squamation.—The scales are best exhibited in the type-specimen (Pl. V, Fig. 2), which shows two very deep series upon the middle of the anterior portion of the flank, the vertical measurement of the deepest being a little more than three times their antero-posterior dimension. Above and below there is also another remarkably deep series; and the only scales as broad as deep are those upon the dorsal and ventral aspects of the abdomen, and upon the caudal pedicle behind the dorsal and anal fins. The dorsal and ventral ridge-scales are conspicuous.

Remarks.—This species is distinguished by the depth of the trunk, the small size of the head, and the relative length of the dorsal fin.

Pristisomus crassus, *sp. nov.*

Pl. V, Figs. 5–7.

Obs.—The principal characters of a very robust species with large scales are illustrated by the following specimens:—

(*a*) Type-specimen, wanting the dorsal fin and the upper lobe of the tail, shown of the natural size in Pl. V, Fig. 5.

(*b*) Head and incomplete trunk, partly shown of the natural size in Pl. V, Fig. 6.

(*c*) Trunk, wanting the head and paired fins, the caudal region being shown of the natural size in Pl. V, Fig. 7.

(*d*) Imperfect fish, showing squamation.

(*e*) Imperfect large fish.

General Form.—Compared with the typical species, the trunk is elongated and robust, the greatest depth being contained about three times in the total length. The head is large, and the distance between the extremity of the snout and the posterior margin of the operculum is at least one quarter of the total length. The dorsal fin is much elevated, being as high as long; and the caudal fin is large.

Head and Opercular Apparatus.—The head in the original of Pl. V, Fig. 6, exhibits a few points of interest, and suggests that there was a certain amount of ossification in the chondrocranium, as in *Dapedius*. Membrane-bones are also well developed, the roof being protected with thick plates, and a slender bone, like the parasphenoid, lying across the orbit. The mouth is small, with closely arranged styliform teeth, two being comprised within the space of a millimetre; and each of these teeth has a stout basal portion, becoming suddenly slender at about its middle. The bones of the opercular fold have a small antero-posterior measurement, but it is almost impossible to distinguish the limits between the different elements; the operculum, however, is probably at least twice as deep as broad, and the suboperculum half the size, as suggested by the type-specimen (Pl. V, Fig. 5).

Appendicular Skeleton.—All the fin-rays are very robust and closely articulated, and fulcra are always distinct. The paired-fins seem to be inserted close to the ventral margin; and the pelvic pair is well developed, each fin having not less than six or seven rays, and its point of insertion not being much nearer to the anal than to the insertion of the pectorals. In the original of Pl. V, Fig. 7, the dorsal fin exhibits fourteen rays, the length of the longest equalling that of the base-line as preserved; and the anal fin is much smaller, with only twelve or thirteen rays. The powerful caudal fin is slightly forked, and comprises not less than sixteen rays.

Squamation.—As usual in the genus, the scales of two series upon the middle of the flank are much vertically elongated, while the series immediately above, and two series below, are also remarkably deep. The lateral line crosses the superior third of the upper of the deepest flank-series.

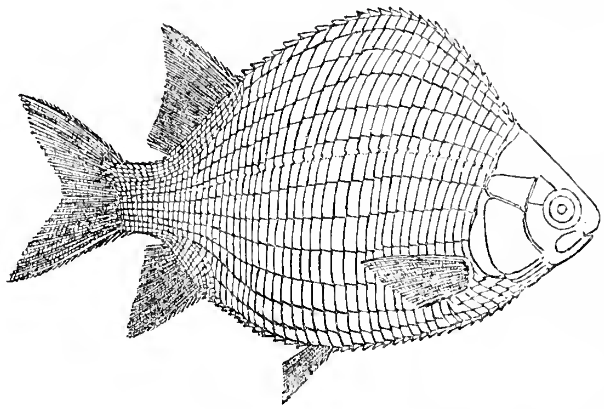
Remarks.—The large size of the head and the robust proportions of *P. crassus* render even imperfect examples at once recognizable.

Genus—CLEITHROLEPIS, *Egerton*, 1864.

(Quart. Journ. Geol. Soc., vol. xx., p. 3.)

Gen. Char.—Head small; snout acute; trunk very deep; the dorsal and anal fins remote and opposite; dorsal margin in advance of the fin considerably arched, ventral margin in advance of the fin more gently arched; caudal pedicle short, the upper lobe scarcely produced; caudal fin slightly forked; pectoral fins large; pelvic fins present; scales deep, united by a peg-and-socket arrangement of the anterior thickened margin; the series between the dorsal and anal fins sharply turned forwards for a short space above and below; ridge-scales present both dorsally and ventrally.

Obs.—This genus was originally founded by Sir Philip Egerton (*loc. cit.*) upon an imperfect specimen discovered in the Hawkesbury rocks of Cockatoo Island, and was naturally compared with the late Palæozoic genus, *Palæoniscus*, from the Permian of Europe. At first sight, the resemblance is certainly striking; and the Australian genus was originally placed in the family of Pycnodontidæ, at that time considered to include fishes of the Platysomid type. A later discovery, however, in the Stormberg beds of South Africa,* has shown that *Cleithrolepis* is nearly related to *Tetragonolepis* (an ally of *Dapedius*), differing both in the structure of the head and the tail from the Platysomidæ. As shown in the accompanying restoration of the type-



species, based upon the fossils described below, the tail is almost homocercal—certainly as much so as in the existing *Lepidosteus;* and no preoperculum can be distinguished. So far as recognizable, there is a narrow regular ring of circumorbital membrane-bones, in addition to distinct suborbitals; and it seems evident, though not absolutely proved, that each ray of the dorsal and anal fins was originally supported by a separate interspinous bone. At the same time, it may be noted that the large relative size of the suboperculum, and the small dimensions of the operculum, are unparalleled among known Dapedioids, while characteristic of Platysomids;† and the peculiar forward reflection of the scales at the base of the dorsal and anal fins is unique in the former group, though well known at least in the anal region of the type-genus of the latter. The singular elevation of the dorsal margin in advance of the dorsal fin is also most suggestive of fishes of the Platysomid family.

Notwithstanding the great number of individuals contained in the present collection, it does not appear possible to recognize with certainty more than a single species—that first described by Egerton under the name of *C. granulatus*—though one imperfect specimen may perhaps indicate a

* Smith Woodward, "On two New Lepidotoid Ganoids from the Early Mesozoic Deposits of the Orange Free State, South Africa," Quart. Journ. Geol. Soc., Vol. xliv, pp. 141–143, Pl. vi, figs. 6, 7.

† See R. H. Traquair, "On the Structure and Affinities of the Platysomidæ," Trans. Roy. Soc. Edinb., 1879, Vol. xxix, pp. 343–391, Pls. iii–vi.

second form. Only one other member of the genus has yet been definitely determined, namely, *C. Extoni*, from the Stormberg beds of Rouxville, Orange Free State, South Africa;* and although it is not impossible that fragments of close allies are already known, both from the Trias of India,† and the Keuper of England,‡ further discoveries must be awaited before any definite statement can be formulated.

Cleithrolepis granulatus, *Egerton.*

Plate VII; Plate VIII, Figs. 2, 3.

Cleithrolepis granulatus, Egerton, Quart. Journ. Geol. Soc., 1864, vol. xx, p. 3, pl. i, figs. 2, 3.

Obs.—Of the numerous examples of this species, the following may be selected as illustrating its main structural features, so far as they are distinguishable:—

(*a*) Small fish, wanting the pelvic fins (Pl. VII, Fig, 1).

(*b*) A small slab of rock, in counterpart, displaying two imperfect individuals of larger size, one being shown in Pl. VII, Fig. 2, and the head of the other in Pl. VII, Fig. 3.

(*c*) Complete trunk, with parts of the head and fins, a portion of the abdominal region shown in Pl. VII., Fig. 4.

(*d*) Large specimen, showing the position of the pelvic fins and well-preserved median fins (Pl. VII, Fig. 5).

(*e*) Two associated fragmentary fishes, one exhibiting the squamation between the dorsal and anal fins (Pl. VIII, Fig. 3).

(*f*) Specimen showing the position and proportions of the pelvic fins (Pl. VIII, Fig. 2).

(*g*) Two associated imperfect fishes, one showing the dorsal serrations (Pl. VII., Fig 7).

(*h*) Imperfect fish, exhibiting a few details of the squamation, six scales of the anterior portion of the lateral line being shown of the natural size in Pl. VII, Fig 6.

(*i*) Large imperfectly preserved fish, 0·11 in length from the posterior edge of the clavicle to the extremity of the caudal pedicle.

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* Smith Woodward, *loc. cit.*

† *Tetragonolepis analis*, Egerton, Pal. Indica, 1878, Ser. 4, Vol. i, Pt. 2 p. 5, Pl. iii, fig 1.

‡ *Dipteronotus cyphus*, Egerton, Quart. Journ. Geol. Soc., 1854, Vol. x, pp. 369-371, Pl. xi.

General Form.—Though a fish of the form of that now under discussion is naturally much distorted, in most cases, when buried in sediment, the study of a large series of specimens seems to reveal approximately its normal proportions. The original of Pl. VII, Fig. 1, may perhaps be taken as a typical example to exhibit the form of the trunk, while the original of Pl. VII, Fig. 5, determines the proportions of the caudal pedicle and fin. The head occupies a little more than one-fifth of the total length of the body (exclusive of the caudal fin), and its height at the anterior margin of the operculum is contained slightly more than two-and-a-half times in the maximum depth of the trunk. The dorsal fin arises at the commencement of the posterior third of the trunk; and the dorsal margin in advance of this is so much arched that, about half-way between the fin and the head, the maximum depth of the trunk equals its extreme length from the back of the clavicle to the base of the caudal fin. The pectoral fins are very large, and the pelvic fins are placed about half-way between the head and the anal fin, while the ventral margin immediately in advance of the latter perceptibly bulges downwards. The caudal fin is relatively large and powerful.

Head and Opercular Apparatus.—The opercular bones and the external elements of the head, Pl. VII, Fig. 3, exhibit a granular ornamentation, but little can be discovered of details. The orbit is well marked, being surrounded by superficial membrane bones, forming apparently a narrow circumorbital ring, bordered postero-inferiorly by large suborbitals (*so.*) between which the sutures are usually indistinct. The membrane-bones of the cranial roof are continued backwards by a large plate extending prominently above the operculum; and between it and the latter element there is sometimes a space that may have been occupied by a chain of bones, such as has been supposed to occur in *C. Extoni.** The operculum (*op.*) is only half as large as the suboperculum (*s. op.*), and almost triangular in shape, owing to the absence of the postero-superior angle; the sub-operculum equals the operculum in width, but is twice as deep; and beneath the last-named bone there are three or four stout branchiostegal rays (*br.*) sometimes distinctly observable. The preoperculum was presumably absent, there being scarcely space for it in its ordinary situation; and no traces of an interoperculum can be recognized.

Appendicular Skeleton.—Several specimens exhibit portions of a long slender clavicle (Pl. VII, Fig. 3, *cl*) and a supraclavicle; but none of the

* Smith Woodward, *loc. cit*, p. 141, Pl. vi, fig. 7.

bones of the pectoral arch are sufficiently displaced and exposed for precise description. The pectoral fin is very large, and placed upon the side of the trunk slightly below the level of the lower margin of the suboperculum. In the original of Pl. VII, Fig. 1, not less than twelve or thirteen rays can be counted, spreading distally, and being at least equal to the head in length. The pelvic fins (Pl. VIII, Fig. 2) were evidently smaller, though well developed for a fish of this type.

Of the median fins (Pl. VII, Fig. 5), the dorsal is longer than the anal, but relatively less elevated; and the posterior points of termination of these fins seem to correspond, the anal thus arising further back than the dorsal. In each fin, the rays gradually diminish in length backwards, and are most widely spaced posteriorly; they are about seventeen in number in the dorsal, and not more than twelve in the anal. Both in these fins and in the caudal, the rays are stout, exhibit numerous articulations, and begin to bifurcate at a considerable distance from the distal extremity, and the fulcra upon the anterior margin are prominent. The caudal fin is well shown in Pl. VII, Fig. 5, being very large and powerful, consisting of twenty-four to twenty-six rays, widely spread, and slightly forked; at its base also are a few large fulcral scales, both above and below.

Squamation.—Though individual scales are rarely distinguishable, the general characters of the squamation can be well determined. Sir Philip Egerton has already pointed out that the scales are deep, superficially granulated, and united together by a peg-and-socket arrangement of the anterior thickened margin. It is now possible to add some interesting information concerning their variation and disposition. The lateral line is prominently marked in specimens sufficiently well preserved (not in Pl. VII, Figs. 1 and 2), by its perforation of a horizontal series of scales almost along the middle line of the flank; and in one specimen (No. *h*) these scales towards the posterior part of the abdominal region are seen to be five or six times as deep as broad, with the perforation marking the lower limit of the superior third or slightly above the middle point (Pl. VII, Fig. 6). The scales above and below this series are also much deeper than broad, except near the dorsal and ventral margin; and upon the caudal region, at the point of origin of the dorsal fin, the vertical series of scales are rapidly narrowed, though in some specimens this feature is evidently emphasised by distortion during fossilization. Moreover, to a depth of about 0·005 from the base both on the dorsal and anal fins, the series of scales are distinctly displaced from their normal direction and trend forwards (Pl. VIII, Figs 2 and 3). There is also an unconformity, so to speak, between the scales immediately beneath the pectoral fin and the ordinary series of the flank. In a triangular area behind and beneath the clavicle (Pl. VII, Fig. 4), extending along the ventral aspect to a point below the middle of the longest pectoral ray, the scales trend downwards and forwards in slight curves of which the concave aspect is anterior; and these, like the normal series behind, are terminated below by prominent ridge-scales. This ventral armature is well seen in several specimens, and evidently implies that the lower portion of the abdomen was, during life, broad, for each scale consists of a right and left half, apparently meeting at a very obtuse angle in the median line. The dorsal margin of the trunk is similarly provided with ridge-scales, but in this case much more acutely compressed from side to side. In badly preserved specimens this superior margin thus appears curiously serrated (Pl. VII, Fig. 7), and there is sometimes a deceptive series of forwardly directed denticulations; but when the scales are distinguishable, those of the ridge are seen to correspond in number with the normal series of the flank, none being crenulated, and each giving rise to only one backwardly-turned point.

Remarks.—So far as known, the South African species, *C. Extoni*, seems to be very closely related to the type-species thus described. It agrees well in the form and proportions of the trunk, and it may be that the differences in the proportions of the fins are due to imperfect preservation. In the dorsal and anal fins of *C. Extoni*, however, a number of the anterior rays are much more closely arranged in comparison with those that follow than is the case in *C. granulatus.*

Cleithrolepis [? altus, *sp. nov.*]

Plate VIII, Fig. 4.

Obs.—As already mentioned, a single specimen in the collection is referable to a form of *Cleithrolepis* with a deeper trunk than that of the normal *C. granulatus*. This fossil is shown of the natural size in Pl. VIII, Fig. 4; and, apart from its shape, it is also interesting as exhibiting feeble impressions of the scales, which have been carefully traced by Mr. Percy Highley, and somewhat emphasised in the drawing.

The arched dorsal margin of the trunk in this unique specimen is much more angulated than usual, and the maximum depth (0·098) exceeds the distance from the posterior margin of the operculum to the end of the caudal pedicle probably by not less than one centimetre. The lateral line proceeds from the level of the upper margin of the operculum, and is gradually arched, assuming a mesial position upon the flank between the dorsal and anal fins. It crosses the superior half of a vertically-elongated series of scales, nearly six times as deep as broad anteriorly; and both above and below this there are other series of considerable depth. The dorsal ridge-scales in advance of the "apex" of the trunk (Pl. VIII, Fig. 4*a*) are twice as broad as many of those behind; and the former display the characteristic superficial granulation.

Family—PHOLIDOPHORIDÆ.

Fam. Char.—Body elongated or fusiform, with enamelled rhombic scales; head with well developed membrane bones, externally enamelled; gape wide, and teeth conical, usually small; snout not produced. Upper lobeof tail externally inconspicuously or very slightly produced. Fin-fulcra minute.

Genus—PHOLIDOPHORUS, *Agassiz*, 1843.

(Rech. Poiss. Foss., vol. ii, pt. i, p. 271).

Gen. Char.—Body fusiform, usually elongated; tail externally homocercal, caudal fin forked; snout obtuse; teeth minute; dorsal fin short, but moderately developed, larger than the anal, and arising above or shortly behind the pelvic fins; pectoral fins small or moderately developed. Scales deeper than broad upon the flank; no continuous series of ridge-scales, but one, two, or three large plates usually present in advance of the median fins.

Obs.—As remarked, especially by Zittel,* several extraneous species were originally referred to this genus, and its limits have thus been somewhat unscientifically extended. Only a single character, however, that might possibly be deemed of generic value, separates one form of Hawkesbury fish from the typical species, *P. Bechei*,† namely, the origin of the dorsal fin posterior to a point opposite the pelvic pair, thus rendering it partly opposed to the anal. This character alone does not appear sufficient for the erection of a distinct genus; and we therefore venture to record the occurrence of a new species of *Pholidophorus* in New South Wales, more especially as Mr. William Davies‡ has lately ascribed to this genus a Purbeckian fish having its dorsal fin in precisely the same remote situation.

* K. A. von Zittel, Handbuch der Palæontologie, 1887, Vol. iii, pp. 214–216.
† L. Agassiz, Rech. Poiss. Foss., 1843, Vol. ii, pt. i, p. 272, Pl. xxxix, figs. 1–4.
‡ W. Davies, "On a New Species of *Pholidophorus* from the Purbeck Beds of Dorsetshire," Geol. Mag., 1887, [3] Vol. iv, p. 338, Pl. x, fig. 1 (*P. brevis*).

PHOLIDOPHORUS GREGARIUS, *sp. nov.*

Plate VI, Figs. 6–10.

Obs.—The small fishes of this species are among the commonest of the Hawkesbury fossils, and seemed to have lived and died in considerable shoals. About seven specimens may be selected to elucidate all the main points in their structure, except the osteology of the skull, of which little can be discerned.

(*a*) The type-specimen, the trunk being preserved in counterpart. This is shown of twice the natural size in Pl. VI, Fig. 6, and is associated on the same slab with two smaller examples.

(*b*) A more incomplete smaller specimen, shown of twice the natural size in Pl. VI, Fig. 7.

(*c*) A still smaller, more elongated fish, shown of twice the natural size in Pl. VI, Fig. 8.

(*d*) Head and anterior portion of trunk.

(*e*) Imperfect head and anterior portion of trunk, the head being shown of twice the natural size in Pl. VI, Fig. 10.

(*f*) A small elongated fish, wanting the fins; the head shown of twice the natural size in Pl. VI, Fig. 9.

(*g*) Four associated small fishes upon one slab, with a small *Dictyopyge*.

General Form.—As shown by the figures, there is considerable variation in the proportions of the individuals assigned to this species; but it does not appear possible to discover any characters by which they can be further separated. The original of Fig. 8 is much smaller and more elongate than the type, but is partly connected with it by No. *b* (Fig. 7); and in two instances these forms are associated upon one slab of rock, as if they formed part of the same shoal. It may also be noted that in the original of Fig. 8 the dorsal and anal fins are depressed, while there are signs of post-mortem compression; and an individual equally slender, upon the slab No. *g*, exhibits the tail as widely spread as that of the type. The head, with the opercular apparatus, does not occupy more than about one-fifth of the total length of the fish; the fin-rays are robust, and, in the median fins, spaced considerably apart; and the dorsal fin is large, arising opposite the space between the pelvic pair and the anal, and partly opposed to the latter.

Head and Opercular Apparatus.—The head is short and rounded, and the snout not produced to a point. The orbit is large, the mouth of moderate size, and the lower jaw stout. As usual, the exposed surfaces of the bones are mostly destroyed, but there are indications of an ornament consisting both of small tubercles and striæ. Of the cranial roof-bones, only the frontals are displayed in impression (Pl. VI, Fig. 9), and these are very suggestive of the corresponding elements of the European *Pholidophorus.** For nearly half of their extent posteriorly they are relatively broad, but the outer lateral margin of each rapidly curves inwards in front, and the anterior third of the bone becomes narrow. Unless appearances in No. *d* are deceptive, the maxilla is long and gently curved, exactly as in the typical *Pholidophorus;* and it also bears a series of minute, conical, pointed teeth. In the mandible, the dentary bone is large and broad, but its dentition is not clearly distinguishable. The post-orbital bones are large, at least two being well shown in No. *e* (Pl. VI, Fig. 10); and the upper of these is quadrangular, about as long as deep, while the antero-inferior angle of the lower is so much produced forwards as to make it appear almost triangular. There is also a mark round the eye in this fossil, which may be either a narrow, regular, circumorbital ring, or merely an ossified sclerotic capsule. The opercular bones are narrow, but the divisional line between the operculum and sub-operculum is not very distinct; this appears, however, to be oblique, and would thus correspond with that of the typical *Pholidophorus.*

Axial Skeleton of Trunk.—There is distinct evidence of the persistence of the notochord, and this is but very slightly produced upwards at its hinder extremity to form a superior caudal lobe. The neural and hæmal arches must also have been imperfectly ossified, for nothing can be discerned as to their form and proportions, even where the scales are removed.

Appendicular Skeleton.—In the pectoral arch the clavicle is slender, and longitudinally striated, at least in its lower portion; and the type-specimen (Pl. VI, Fig. 6) exhibits indications of two of the large post-clavicular scales. The pectoral fins are moderately powerful, each consisting of about eight or nine rays, the first four or five especially stout, and the remainder more delicate and closely arranged (Pl. VI, Fig. 6). The pelvic fins are small, each consisting probably of not more than five or six rays;

* L. Agassiz, *Tome cit.*, Pt. i, p. 286, Pl. xlii *a*, fig. 5 (*Pholidophorus minor*)

and they are placed about half-way between the pectorals and the anal, though generally nearest to the latter.

The median fins are large and powerful, all consisting of a few strong, widely-spaced rays, articulated and bifurcated distally. In front of each there are three or four small polished rays, to be regarded as representing fulcra; and in the dorsal and anal fins the number of supporting inter-spinous bones exactly corresponds to that of the ordinary rays. The dorsal fin is larger than the anal, the one comprising not less than twelve rays and the other only about eight; and the latter commences at a point opposite the middle of the former. The caudal fin has the appearance of being somewhat excavated, but it was probably not deeply forked. The upper lobe of the caudal pedicle is atrophied, and the number of rays is about fourteen.

Squamation.—The large rhombic scales with which the fish is covered appear to have been originally thick and enamelled, but they are generally much abraded, and both dorsally and ventrally upon the caudal region they are nearly always destroyed. None exhibit any traces of serrations upon the posterior margin. Those of the flanks are best shown in No. *b* (Pl. VI, Fig. 7), and as far back as the origin of the anal fin at least, four horizontal series are much deeper than long. The scales of the lateral line are deepest, and the "line" itself crosses each of these obliquely nearest its upper extremity, producing a prominent ridge. There is one series of vertically-elongated scales above the lateral line, and two can be distinguished below; and the few series placed dorsally and ventrally comprise smaller scales of more equilateral form. There are no ridge-scales, except immediately in front of the median fins. One or two large oval scales occur in front of the dorsal; there are three both on the upper and lower margin of the caudal pedicle; and a small fish on the slab with the counterpart of the type-specimen, exhibits two (or perhaps three) others in advance of the anal.

Remarks.—From all species of similar proportions *P. gregarius* is distinguished by the remote situation of the dorsal fin.

Genus—PELTOPLEURUS, *Kner*, 1866.

(Sitzungsb. math.-naturw. Cl. kongl. Akad. Wiss., vol. liii, pt. i, p. 180.)

Gen. Char.—Body deeply fusiform; tail externally homocercal; caudal fin forked; snout obtuse; teeth minute. Paired fins feebly developed; dorsal and anal fins small and short, the former at least in part opposed to the latter, though usually arising in advance of this. Scales of the flank in one [or three] deep series; dorsal and ventral scales nearly equilateral; ridge-scales absent.

Obs.—This interesting genus has hitherto been discovered only in the Keuper of Raibl, Carinthia,* and of Seefeld, in the Tyrol,† and it is somewhat doubtful whether we are now justified in recording its occurrence in the Hawkesbury beds of New South Wales. In the Survey Collection, however, there is a small species, which, so far as can be determined, only differs from the typical *Peltopleurus* in the character added to the above definition in square brackets. It is perhaps contrary to analogy to permit such an extension of the genus; but, under any circumstances, the Hawkesbury fish is closely related to the European type just mentioned, and, awaiting further discoveries, it may be provisionally placed here.

PELTOPLEURUS (?) DUBIUS, *sp. nov.*

Pl. VI, Figs. 4, 5.

Obs.—From an extensive series of specimens, the following may be selected as characteristic and comparatively well preserved:—

(*a*) Type-specimen, wanting the pectoral fins, shown of the natural size in Pl. VI, Fig. 4.

(*b*) Imperfect fish, displaying the squamation, shown of twice the natural size in Pl. VI, Fig. 5.

(*c*) A smaller fish, apparently of more slender proportions.

General Form.—Some examples of the fish are a little more elongated than others, but the differences seem to be mainly due to *post-mortem* distortion. The type-specimen probably displays the original proportions, and in this the caudal pedicle is short and slender, and the maximum depth of the abdominal region is contained about three times in the total length of the fish. The head and opercular apparatus occupy considerably less than a quarter of the total length. The dorsal fin is somewhat larger than the anal, and arises just in advance of the latter.

* *P. splendens*, R. Kner, Sitzungsb. math.-naturw. Cl. k. Akad. Wiss., 1866, Vol. liii, Pt. i, pp. 180–183, Pl. iv, fig. 3.

† *P. humilis*, R. Kner, *ibid.*, 1867, Vol. lvi, Pt. i, p. 904, Pl. 1, fig. 2.

Head and Opercular Apparatus.—There is nothing worthy of remark concerning the bones of the head, few sutures being distinguishable. The orbit is large and bordered postero-inferiorly in the usual manner with broad suborbitals; and the slender jaws seem to have been provided with minute teeth. The opercular apparatus is equal in width to the posterior suborbitals; and either the operculum or suboperculum is at least twice as deep as broad.

Appendicular Skeleton.—The paired fins seem to have been very small and delicate, for the pectorals are in every case destroyed, and only traces of the pelvic pair are observed in the type-specimen (Pl. VI, Fig. 4). The latter are placed nearer to the anal fin than to the probable insertion of the pectorals. The dorsal fin arises very slightly in advance of the anal, with eleven rays in the type-specimen; and the length of the longest anterior ray equals half the depth of the trunk at its insertion. The anal fin also exhibits ten or eleven rays, and is evidently at least as elevated as the dorsal, though with a shorter base-line. The caudal fin is not completely preserved in any specimen, but it consists of not less than sixteen rays, and was probably somewhat forked. In advance of each of the median fins there are slender basal fulcra, continued as a very minute fulcral fringe upon the anterior ray; and each of the rays is broad and divided at distant intervals by transverse joints, while there is usually a distal bifurcation.

Squamation.—The scales are best displayed in an impression shown of twice the natural size in Pl. VI, Fig. 5. The principal portion of the flank is occupied by three deep series, of which the uppermost is traversed by the lateral line (Pl. VI, Fig. 4), and above and below are two or three small series of nearly equilateral diamond-shaped scales, such as also predominate towards the end of the caudal pedicle.

Remarks.—So far as can be determined from the foregoing description, it will be observed that the Australian species only differs essentially from the typical *Peltopleurus* in the single series of deep flank-scales being represented by three series. In this respect it approaches *Pholidophorus*, and other features also are suggestive of the latter genus. The trunk, however, in the species now under consideration is deeper than is usual in *Pholidophorus*, the opercular bone already described is most nearly paralleled by the operculum of *Peltopleurus*, and there are apparently no large azygous scales in front of the median fins, such as characterize *Pholidophorus*. We therefore venture to assign the fish only a provisional generic position.

Genus non det.

Pl. VI, Figs. 11, 12.

The imperfect anterior portion of a small elongated fish is shown of the natural size in Pl. VI, Fig. 11, and a few of the scales are enlarged five times in Pl. VI, Fig. 12. The specimen, however, is too imperfect for generic determination, and it is only noticed to point out the possibility that it may indicate the occurrence in the Hawkesbury beds of the genus *Ptycholepis*, Agassiz. The gape of the mouth is evidently wide; the suspensorium is slightly oblique; and the body is covered with small, narrow scales, difficult to interpret in the impression, but probably somewhat as represented in the enlarged figure. A few rays of the pectoral fin are preserved, while the pelvic fin consists of very delicate rays, and seems to have an extended base-line. If the fossil does not represent an ally of *Ptycholepis,* it probably pertains to some fish of the type of *Dictyopyge*.

III.—CONCLUSION.

As the result of the researches detailed in the foregoing Memoir, the Fish-fauna of the Hawkesbury beds at Gosford may be tabulated as follows :—

Selachii.

Genus non det.

Dipnoi.

Gosfordia, *gen. nov.*
  „ truncata, *sp. nov.*

Ganoidei.

PALÆONISCIDÆ.

Myriolepis, *Egerton.*
  „ Clarkei, *Egerton.*
  „ latus, *sp. nov.*
Apateolepis, *gen. nov.*
  „ australis, *sp. nov.*

CATOPTERIDÆ.

Dictyopyge, *Egerton.*
  „ symmetricus, *sp. nov.*
  „ illustrans, *sp. nov.*
  „ robustus, *sp. nov.*

BELONORHYNCHIDÆ.

Belonorhynchus, *Bronn.*
  „ gigas, *sp. nov.*
  „ gracilis, *sp. nov.*

SEMIONOTIDÆ.

Semionotus, *Agassiz.*
  „ australis, *sp. nov.*
  „ tenuis, *sp. nov.*
Pristisomus, *gen. nov.*
  „ gracilis, *sp. nov.*
  „ latus, *sp. nov.*
  „ crassus, *sp. nov.*
Cleithrolepis, *Egerton.*
  „ granulatus, *Egerton.*
  „ (?) altus, *sp. nov.*

PHOLIDOPHORIDÆ.

Pholidophorus, *Agassiz.*
,, gregarius, *sp. nov.*
(?) Peltopleurus, *Kner.*
,, (?) dubius, *sp. nov.*

An examination of this list at once demonstrates that the Fauna is of early Mesozoic age, and as only one rhombic-scaled ganoid with a semi-heterocercal tail (*Acentrophorus*[1]) has hitherto been discovered below the Trias, it will suffice to institute comparisons with the known Fish-faunas of Triassic, Rhætic, and Liassic date.

Little is known of the fossil fishes of the Lower Trias (Bunter) of Europe, only two species (*Dictyopyge rhenana*, and *Semionotus alsaticus*) having been definitely determined from the valley of the Rhine.[2] From the Muschelkalk and Lettenkohle, however, numerous species are more or less satisfactorily described. In addition to teeth of Selachians and the Dipnoan *Ceratodus*, Agassiz[3] described many fragmentary remains of Ganoids from the Continental Muschelkalk. H. von Meyer,[4] P. Gervais,[5] E. E. Schmid,[6] and others made similar contributions. W. Dames[7] has considerably extended our knowledge of *Gyrolepis*, *Colobodus*, and *Serrolepis*, besides adding a previously unknown Lepidosteoid genus, *Crenilepis*; and quite lately W. Deecke[8] has described an extensive series of fishes from the Muschelkalk of Perledo, on the Lake of Como, already briefly noticed by Bellotti.[9]

In the European Upper Trias, or Keuper, fossil fishes are still more numerous and have been described from various localities in England, Ireland, and Germany, from Seefeld in the Tyrol, and from Raibl in Carinthia. Species of *Dictyopyge*,[10] *Semionotus*,[11] and a Dapedioid genus, *Dipteronotus*,[12] are

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[1] R. H. Traquair, Quart. Journ. Geol. Soc., 1877, Vol. xxxiii, pp. 562-565.

[2] W. Deecke, "Fische aus dem Buntsandsteine des Rheinthales," Palæontographica, 1889, Vol. xxxv, pp. 98-108, Pl. vi, figs. 1, 11.

[3] L. Agassiz, Recherches sur les Poissons Fossiles, 1843, Vol. ii, *passim*.

[4] H. von Meyer, "Fossile Fische aus dem Muschelkalk von Jena, Querfurt und Esperstädt," and "Fische, etc., aus dem Muschelkalk Oberschlesiens," Palæontographica, 1849, Vol. i.

[5] P. Gervais, Zoologie et Paléontologie Francaises, Ist. edit. 1852.

[6] E. E. Schmid, "Die Fischzähne der Trias bei Jena," Nova Acta Acad. Cæs. Leop.-Car., 1861, Vol. xxix, No. 9.

[7] W. Dames, "Die Ganoiden des deutschen Muschelkalks," Pal. Abhandlungen, 1888, Vol. iv, pt. 2.

[8] W. Deecke, "Fische aus den schwarzen Schiefern von Perledo," Palæontographica, 1889, Vol. xxxv, pp. 110-133, with figs.

[9] C. Bellotti, "Descrizione di Alcune Nuove Specie di Pesci Fossili di Perledo e di Altre Localita Lombarde," in A. Stoppani, "Studii Geol. e Paleont. Lombardia," 1857, pp. 419-438 (without figs.)

[10] *Dictyopyge superstes*, Egerton sp.

[11] E. T. Newton, "On the Remains of Fishes from the Keuper of Warwick and Nottingham," Quart. Journ. Geol. Soc., 1887, Vol. xliii, pp. 537-539, Pl. xxii, figs. 1-8.

[12] Sir Phillip Egerton, "On a Fossil Fish from the Upper Beds of the New Red Sandstone at Bromsgrove," Quart. Journ. Geol. Soc., 1854, Vol. x, pp. 367-371. Pl. xi.

known from the English Keuper; and *Dictyopyge catopterus*[1] occurs in beds of corresponding age at Tyrone, Ireland. Four species of *Semionotus*[2], and one of *Dictyopyge*[3], are recognized in the German Keuper, while *Belonorhynchus* probably occurs[4]; and the deposits both of Raibl and Seefeld are very prolific, as shown by the well-known memoirs of Kner.[5]

In the United States, the Trias of the Connecticut Valley, and of New Jersey and Virginia, also yields fossil fishes of the genera *Dictyopyge*,[6] *Catopterus*,[7] *Semionotus* (*Ischypterus*),[8] *Diplurus*,[9] and *Ptycholepis*[10]; and a single imperfect specimen from Virginia pertains to a deep-bodied fish, perhaps related to *Dapedius*.

In South Africa, the Karoo Formation has furnished a few fossils referable to the genera *Semionotus*,[11] *Cleithrolepis*,[12] and undescribed Palæoniscidæ; and the early Mesozoic Koto Group of India yields *Lepidotus*, *Dapedius*, *Tetragonolepis*,[13] and possibly *Cleithrolepis*,[14] while the Maleri beds of the same country add teeth of *Ceratodus*.[15]

The fossil fishes of the Rhætic beds are mostly known only by detached teeth and scales, described by Agassiz (*op. cit.*), Meyer and Plieninger,[16] Quenstedt,[17] and others, from the bone-beds of Gloucestershire and Würtemberg. Species of *Pholidophorus*,[18] however, and a closely allied genus, *Legnonotus*,[19] are determined by Egerton from the Rhætic of Aust Cliff, near

[1] See R. H. Traquair, Quart, Journ. Geol. Soc., 1877, Vol. xxxiii, pp. 565-567.

[2] *Semionotus Bergeri*, Agassiz; *S. Kapffi*, O. Fraas; *S. serratus*, O. Fraas; and *S. elongatus*, O. Fraas.

[3] *Dictyopyge socialis*, Berger, sp.

[4] Portions of mandible in the Stuttgart Museum.

[5] R. Kner, "Die Fische der bituminösen Schiefer von Raibl in Kärnthen," Sitzungsb. math. naturw. Cl. k. Akad. Wiss., 1866, Vol. liii, Pt. i. pp. 152-197, pls. i-vi. "Nachtrag zu den fossilen Fischen von Raibl," *ibid.*, 1867, Vol. lv, Pt. i, pp. 718-722, with plate. "Die fossilen Fische der Asphaltschiefer von Seefeld in Tirol," *ibid.*, 1866, Vol. liv, Pt. i, pp. 303-334, Pls. i-vi. "Nachtrag zur fossilen Fauna der Asphaltschiefer von Seefeld in Tirol," *ibid.*, 1867, Vol. lvi, Pt. i, pp. 898-913, Pls. i-iv.

[6] *Dictyopyge macrura*, W. C. Redfield sp.

[7] *Catopterus graciles*, J. H. Redfield, Ann. New York Lyceum Nat. Hist., 1848, Vol. iv. p. 37, Pl. i. *C. anguilliformis* and *C. parvulus*, W. C. Redfield, Amer. Journ. Sci., 1841, Vol. xli p.p. 27-28. *C. Redfieldi*, Egerton, Quart. Journ. Geol. Soc., 1847, Vol. iii p. 278.

[8] See Sir Phillip Egerton, Quart. Journ. Geol. Soc., 1847, Vol. iii p. 277; and *ibid.*, 1850, Vol. vi p. 8.

[9] *Diplurus longicaudatus*, J. S. Newberry, Ann. New York Acad. Sci., 1879, Vol. i, p. 127.

[10] *Ptycholepis Marshi*, J. S. Newberry, *ibid.*, p. 127.

[11] *Semionotus capensis*, A. S. Woodward.

[12] *Cieithrolepis Extoni*, A. S. Woodward.

[13] Sir Philip Egerton, "On some Remains of Ganoid Fishes from the Deccan," Pal. Indica, 1878, Ser. 4, No. 2.

[14] *Tetragonolepis analis*, Egerton, *ibid.*, p. 5, Pl. iii, fig. 1.

[15] L. C. Miall, "On the Genus *Ceratodus*, with special reference to the Fossil Teeth found at Malédi." Pal. Indica, 1878, Ser. 4, No. 2.

[16] H. von Meyer and T. Plieninger, "Beiträge zur Paläontologie Wurttembergs," 1844.

[17] F. A. Quenstedt, "Der Jura," 1856.

[18] *Pholidophorus Higginsi* and *P. nitidus*, Egerton, Mem. Geol. Surv., Gt. Brit., 1855, Dec. viii No. 7, pp. 1-3, Pl. vii, figs. 1-8.

[19] Egerton, *ibid.*, No. 7, pp. 4, 5, Pl. vii, figs 9-12

Bristol; another *Pholidophorus* is known from Germany[1]; and a skull of *Ceratodus* was discovered in 1886 in the Rhætic of Austria.[2]

The most prolific of the fish-bearing horizons of the Lias is the well-known lower division of Lyme Regis, Dorsetshire, with its equivalents in other parts of England. Here, indeed, nearly all the principal Liassic genera are so well represented that reference need not be made to any corresponding Fauna elsewhere. In addition to several Selachians and Chimæroids, and one Sturgeon (*Chondrosteus*), there are four genera and species of Palæoniscidæ,[3] at least one genus of Cœlacanthidæ,[4] and a single species of the remarkable *Belonorhynchus*.[5] *Semionotus* is absent,[6] but *Dapedius*[7] (including *Amblyurus*[8]), *Lepidotus*,[9] *Pholidophorus*,[10] *Eugnathus*,[11] including *Conodus*,[12] *Heterolepidotus*,[13] and *Lissolepis*,[14] and *Ptycholepis*[15] represent the early Lepidosteoids; a species of *Mesodon*[16] belongs to the Pycnodontidæ; *Pachycormus*[17] points towards a higher type of fish organization; and *Leptolepis*[18] is the forerunner of fishes with completed vertebral centra. There are also other genera of more doubtful position, including *Platysiagum*,[19] *Endactis*,[20] *Isocolum*,[21] *Osteorhachis*,[22] and *Harpactira*.[23]

In comparing these various faunas with that of the Hawkesbury beds, it is obviously only necessary to make a selection of the leading types pertaining to the more specialized groups. Cœlacanths being absent at Gosford, they may be dismissed from consideration; and the Palæoniscidæ

[1] *Pholidophorus Roemeri*, K. Martin, Zeitschr. deutsch. Geol. Ges., 1874, Vol. xxvi pp. 816-819, Pl. xxix, figs. 1, 2.

[2] D. Stur, Verh. k. k. Geol. Reichsanst. Wien, 1886, pp. 381-383.

[3] *Centrolepis asper*, Egerton, Mem. Geol. Surv. 1858, Dec. ix No. 5. *Cosmolepis Egertoni*, Egerton, *ibid.*, Dec. ix, No. 1. *Oxygnathus ornatus*, Egerton, *ibid.*, 1855, Dec. viii No. 9. *Thrissonotus Colei*, Egerton, *ibid.*, Dec. ix, No. 2.

[4] *Holophagus*, Egerton, *ibid.*, 1866, Dec. xii p. 26, Pl. vi; and *ibid.*, 1872, Dec. xiii No. 10.

[5] *Belonostomus acutus*, L. Agassiz, "Rech. Poiss. Foss.," 1843, Vol. ii, Pt. ii p. 142, Pl. xlvii *a*, figs. 3, 4. Probably identical with *Belonostomus Anningiæ*, L. Agassiz, *tom. cit.*, Pt. ii, p. 143 (name only), assigned to *Belonorhynchus* by Smith Woodward, Ann. and Mag. Nat. Hist. [6] Vol. i, p. 354.

[6] The so-called *Semionotus rhombifer*, Agassiz, is *Heterolepidotus*, Egerton (Smith Woodward, Ann. and Mag. Nat. Hist. [5] Vol. xx, p. 178).

[7] L. Agassiz, *tom. cit.*, Pt. i, p. 181.

[8] L. Agassiz, *tom. cit.*, Pt. i, p. 220.

[9] L. Agassiz, *tom. cit.*, Pt. i, p. 233.

[10] L. Agassiz, *tom. cit.*, Pt. i, p. 271.

[11] L. Agassiz, *tom. cit.*, Pt. ii, p. 97.

[12] L. Agassiz, *tom. cit.*, Pt. ii. p. 105 (name only).

[13] Egerton, Mem. Geol. Surv., 1872, Dec. xiii, Nos. 2, 3.

[14] J. W. Davis, Ann. and Mag. Nat. Hist. 1884, [5] Vol. xiii pp. 448-453, Pl. xvi.

[15] L. Agassiz, *tom. cit.*, Pt. ii, p. 107.

[16] *Pycnodus liassicus*, Egerton, *loc. cit.* 1855, Dec. viii, No. 10. Assigned to *Mesodon* by J. J. Heckel, Denkschr. math.-naturw. Cl. k. Akad. Wiss. Wien, 1856, Vol. xi p. 202.

[17] L. Agassiz, *tom. cit.*, Pt. ii, p. 110.

[18] L. Agassiz, *tom. cit.*, Pt. ii, p. 129.

[19] Egerton, *loc. cit.*, 1872, Dec. xiii No. 6.

[20] Egerton, *ibid*, 1858, Dec. ix, No. 4.

[21] Egerton, *ibid*, 1872, Dec. xiii No. 4.

[22] Egerton, *ibid*, 1872, Dec. xiii No. 5.

[23] *Harpactes*, Egerton, Geol. Mag. 1876, [2] Vol. iii p. 441. *Harpactira*, Egerton, *ibid*, p. 576.

are not of much importance, though, as already pointed out, the Hawkesbury *Myriolepis* is most nearly related to the lower Liassic *Thrissonotus*. Dipnoans and Selachians, too, do not call for remark; and the known distribution of the really significant genera may be concisely arranged in tabular form, thus:—

TABLE SHOWING THE GEOLOGICAL AND GEOGRAPHICAL DISTRIBUTION OF THE VARIOUS GENERA.

	Bunter.	Muschelkalk.		Keuper.				Rhætic.	L. Lias.	"Trias."	Koto beds.	Karoo beds.	Hawkesbury beds.
	Germany.	Germany.	Perledo.	England.	Germany.	Seefeld.	Raibl.	England and Germany.	England.	U.S.A.	India.	S. Africa.	N.S.W.
CATOPTERIDÆ.													
Catopterus	......	......	......	......	......	......	......	......	......	×	......	......	......
Dictyopyge	×	......	......	×	×	......	......	......	......	×	......	......	×
BELONORHYNCHIDÆ.													
Belonorhynchus	......	......	×	......	×	×	×	......	×	......	......	......	×
Saurichthys	......	×	......	......	......	......	......	×	......	......	......	......	......
SEMIONOTIDÆ.													
Semionotus	×	......	×	×	×	×	......	×	......	×	......	×	×
Pristisomus	......	......	......	......	......	......	......	......	......	......	......	......	×
Dapedius	......	......	......	......	......	......	......	......	×	?	×	......	......
Cleithrolepis	......	......	......	......	......	......	......	......	......	......	?	×	×
Tetragonolepis	......	......	......	......	......	......	......	......	×	......	×	......	......
LEPIDOTIDÆ.													
Lepidotus	......	......	......	......	......	×	......	......	×	......	×	......	......
PHOLIDOPHORIDÆ.													
Pholidophorus	......	......	×	......	......	×	×	×	×	......	......	......	×
Ophiopsis	......	......	×										
Ptycholepis	......	......	......	......	......	......	×	......	×	×	......	......	......
PACHYCORMIDÆ.													
Pachycormus	......	......	......	......	......	×	......	......	×	......	......	......	......
LEPTOLEPIDÆ.													
Leptolepis	......	......	......	......	......	......	......	......	×	......	......	......	......
Megalopterus	......	......	......	......	......	......	×	......	......	......	......	......	......
PYCNODONTIDÆ.													
Mesodon	......	......	......	......	......	......	......	......	×	......	......	......	......

Of the six Hawkesbury genera comprised in this list, it will thus be observed that four are represented in the European Trias, two of these (*Dictyopyge* and *Semionotus*) being typically Triassic, another (*Belonorhynchus*) commonly ranging to the Lias, and the fourth (*Pholidophorus*) being best developed in this and later Jurassic deposits. The fifth genus (*Pristisomus*) is new, but scarcely higher in rank than *Semionotus*; and *Cleithrolepis* has only been definitely recognized elsewhere in the Stormberg beds of South Africa, which may be either late Triassic, Rhætic, or Lower Jurassic.

Perhaps the most important fact, however, is the absence in the Hawkesbury beds of fishes with well-developed vertebral centra. Only one fragment of a fish of this type (*Megalopterus*) has hitherto been discovered in the European Keuper, and nothing is known of any allies in the Rhætic; but in the Lower Lias, *Leptolepis* is one of the most abundant and characteristic fossils, and well distinguishes the horizon from those beneath. Moreover, *Pachycormus* occurs in the Lower Lias, and seems to have only a single Triassic representative at Seefeld*; and in the British Museum there are now examples of the Pycnodont *Mesodon* from three Lower Liassic localities.

In the Fish-fauna of the Lower Lias, there are thus several elements that become especially characteristic in later Jurassic times, and of which there are no traces in the Hawkesbury collection; though they have two solitary representatives in the uppermost European Keuper. So far as can be determined from the fishes, therefore, the Hawkesbury beds may be regarded as homotaxial with the Keuper of Europe, or, at latest, with the Rhætic; and, on the whole, the present writer is inclined to adopt the first of these interpretations.

* *Eugnathus insignis*, R. Kner, Sitzungsb. math.-naturw. Cl. k. Akad. Wiss. Wien, 1866, Vol. liv, Pt. i, pp. 306–313, Pl. i.

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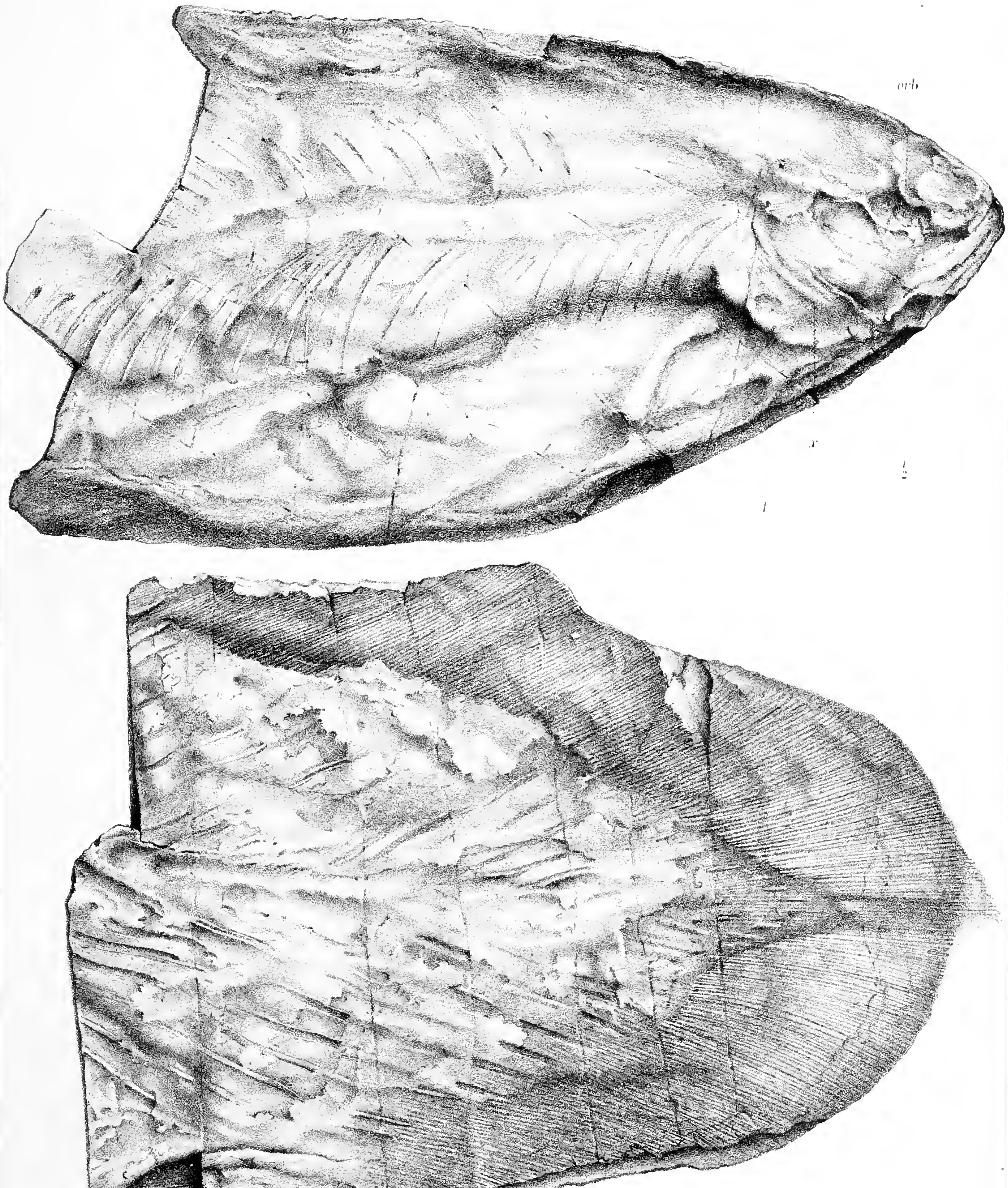

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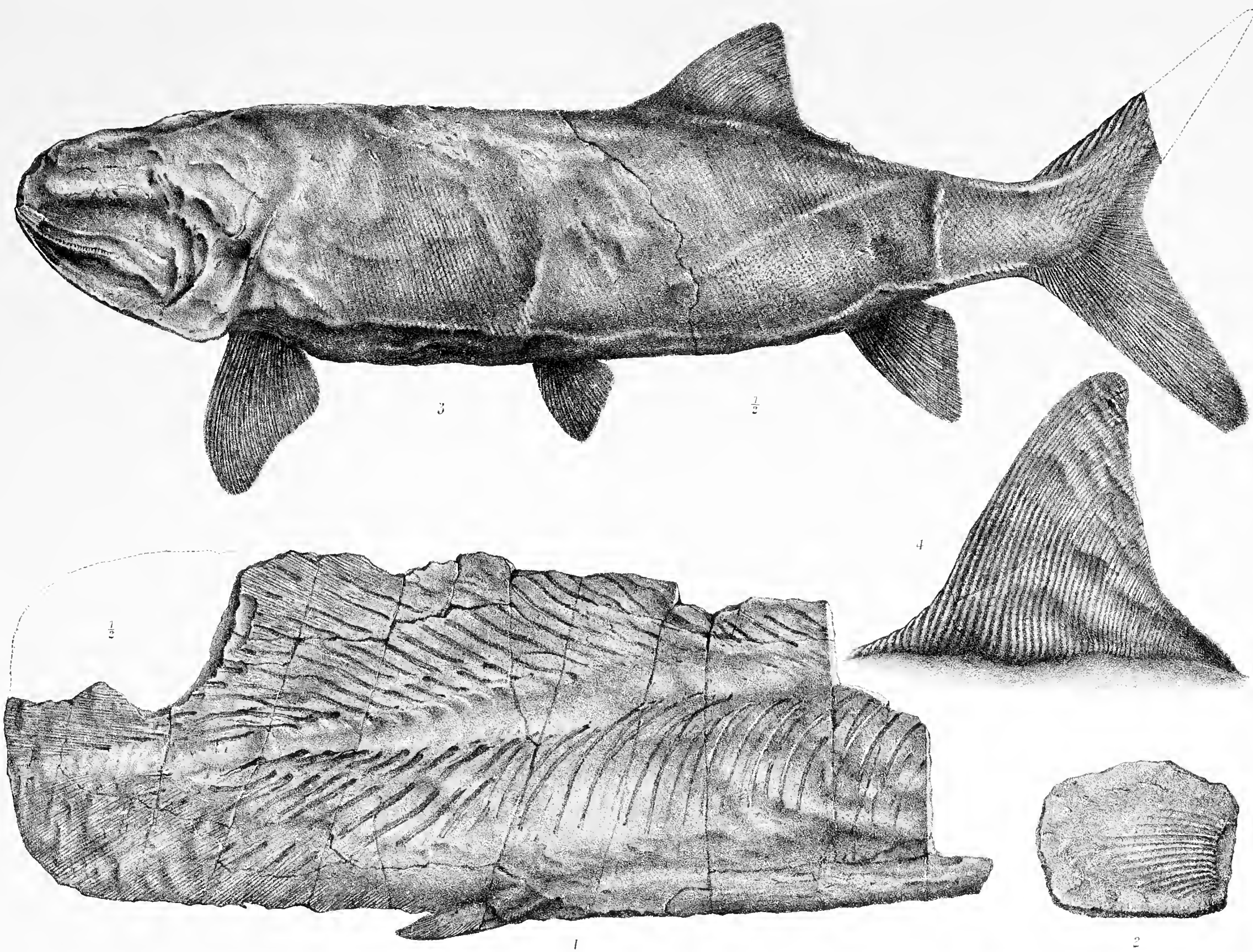
GOSFORDIA.

PLATE II.



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1, 2. GOSFORDIA. 3, 4. MYRIOLEPIS.

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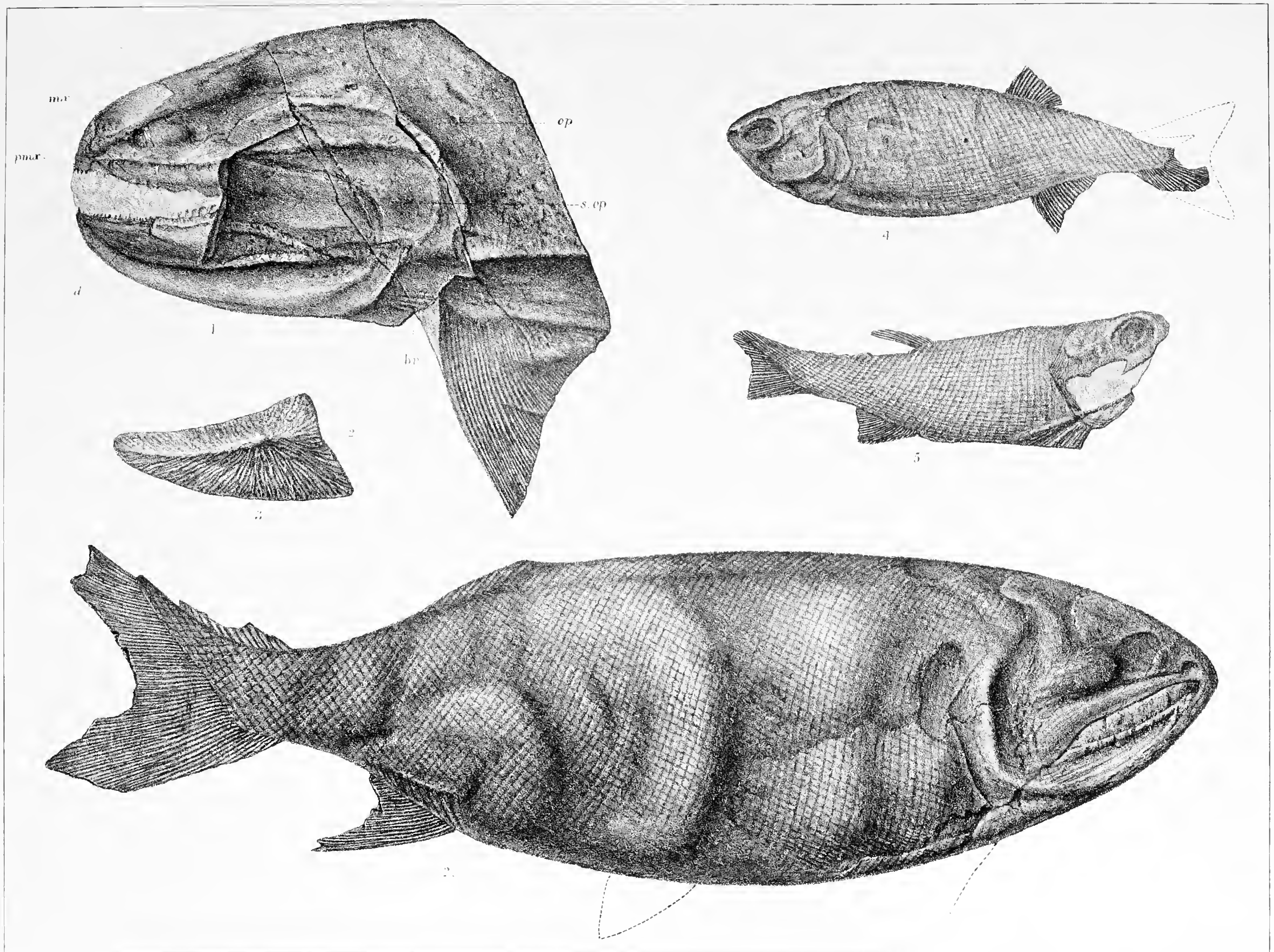

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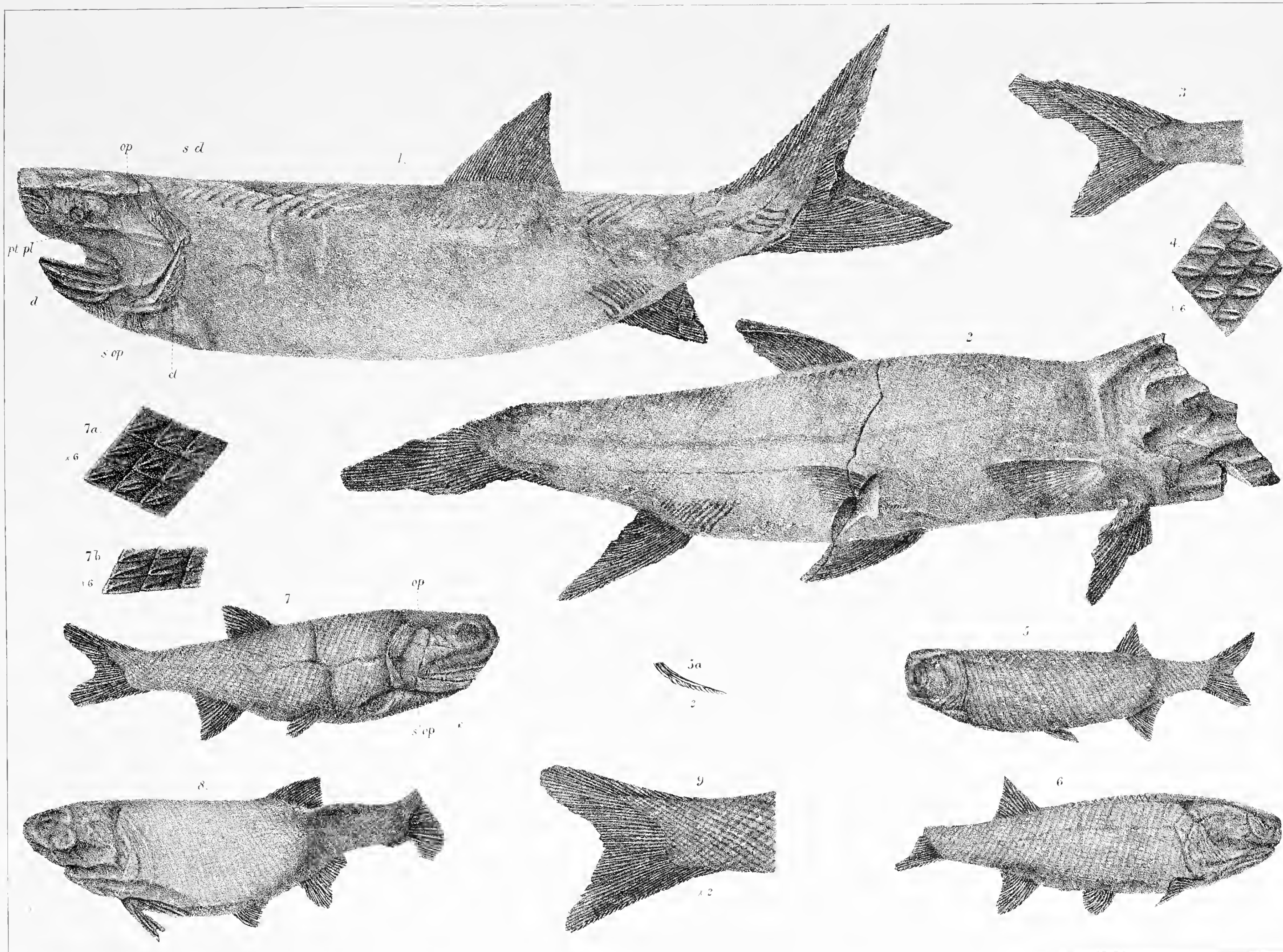
1–3. MYRIOLEPIS. 4, 5. DICTYOPYGE.

PLATE IV.



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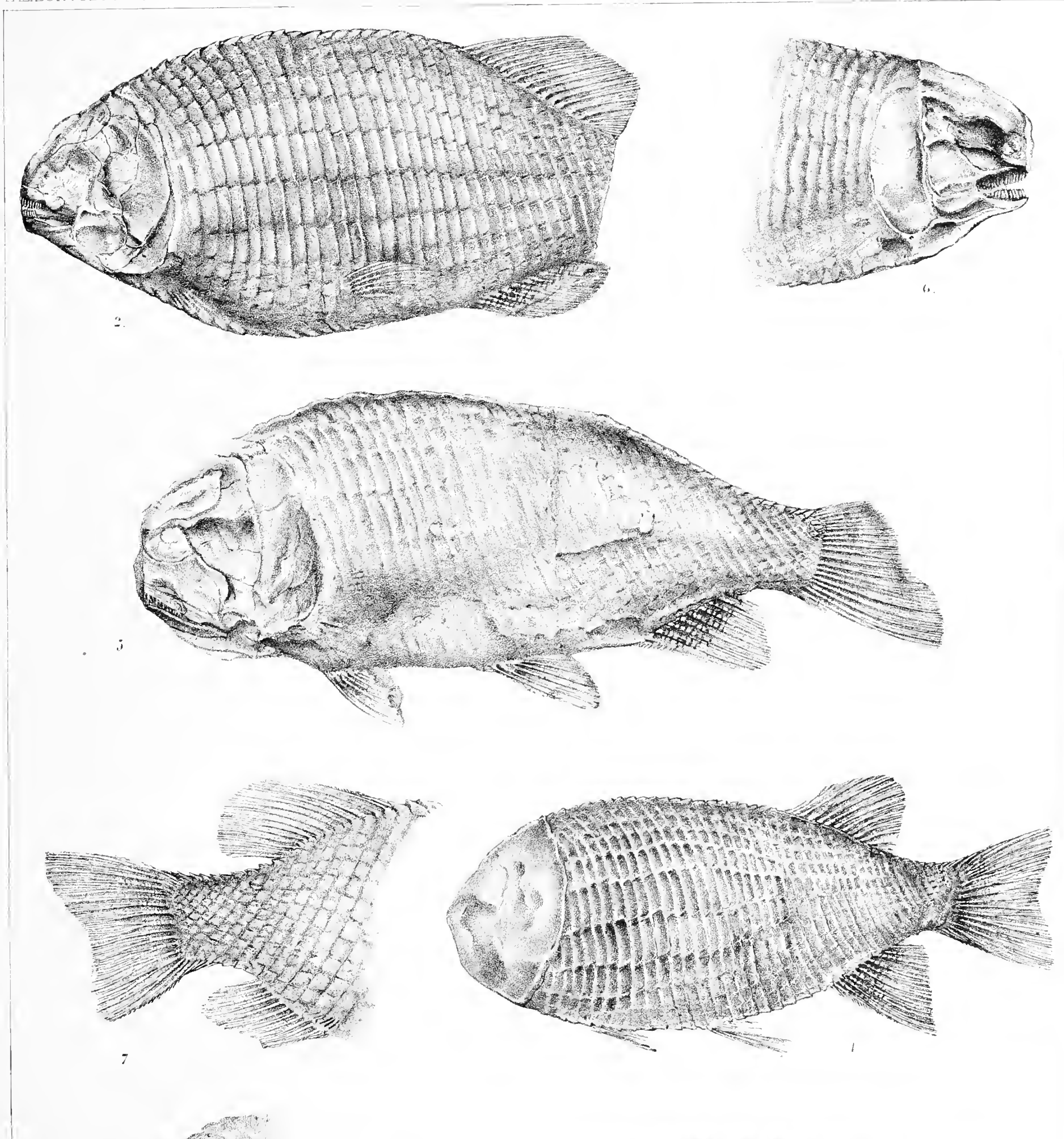
1–4. APATEOLEPIS. 5–9. DICTYOPYGE.

PLATE V.



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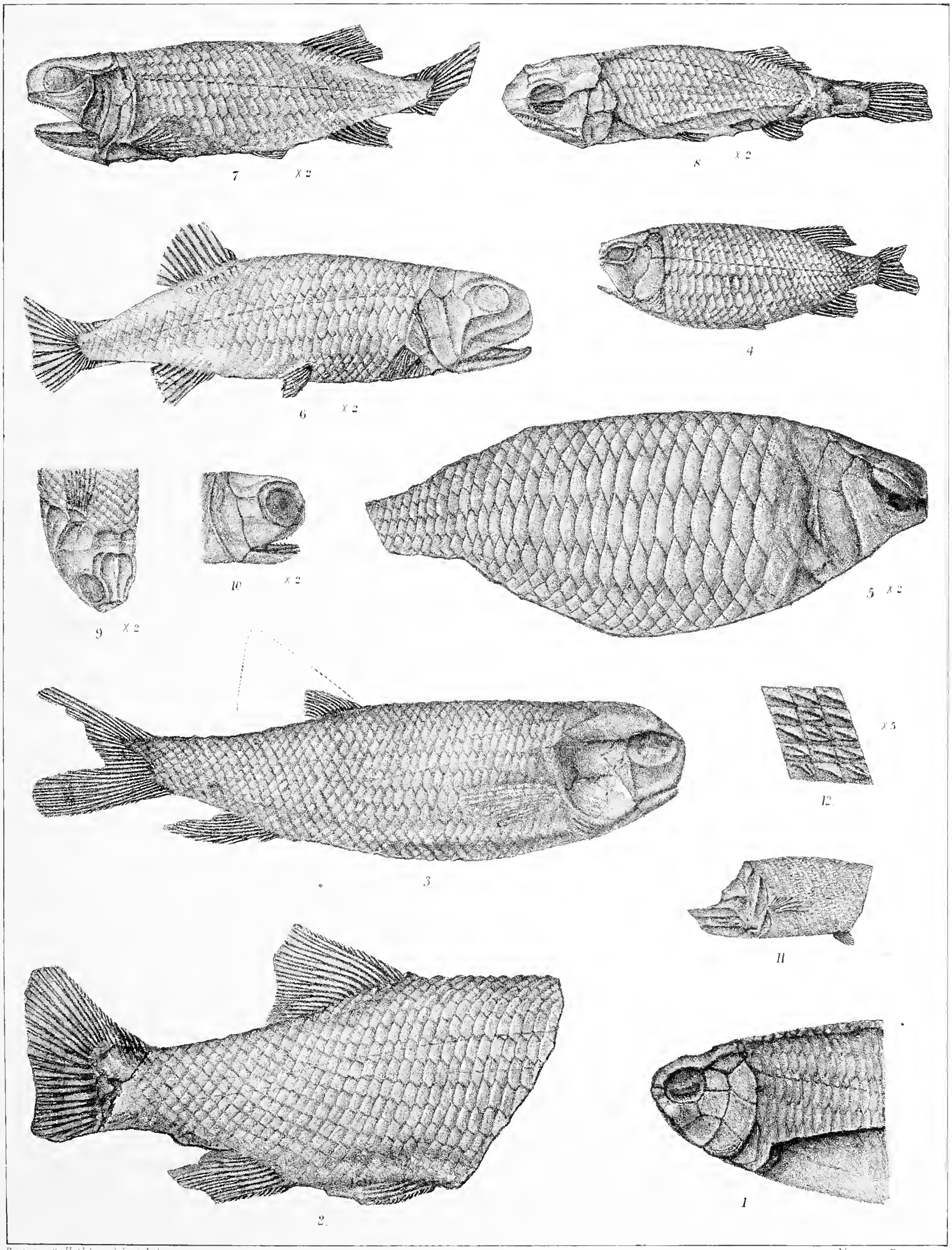
PRISTISOMUS

PLATE VI.



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1. PRISTISOMUS. 2, 3. SEMIONOTUS. 4, 5. PELTOPLEURUS (?). 6–10. PHOLIDOPHORUS.
11, 12. GENUS NON DET.

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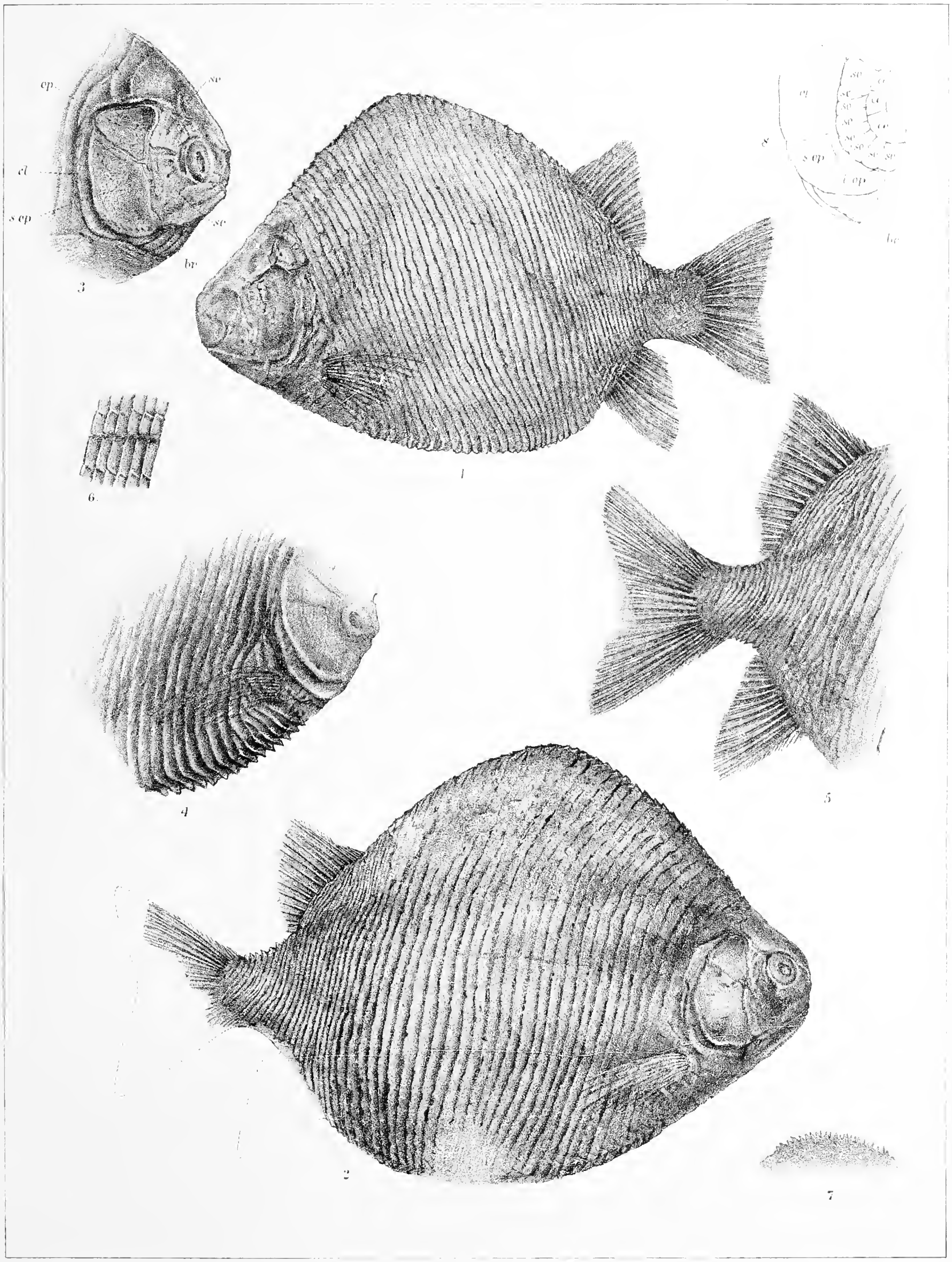

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CLEITHROLEPIS.

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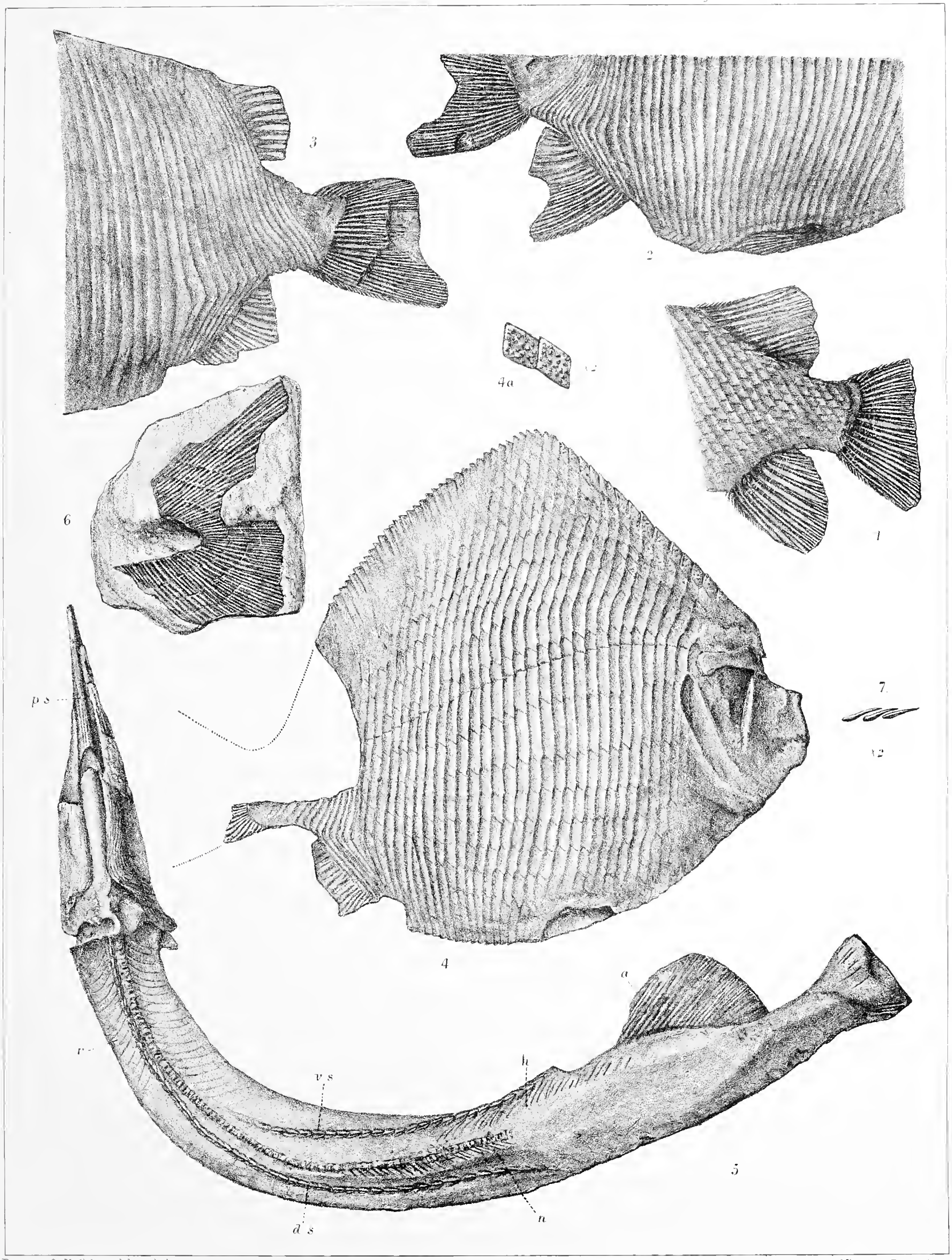

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1. PRISTISOMUS. 2–4. CLEITHROLEPIS.
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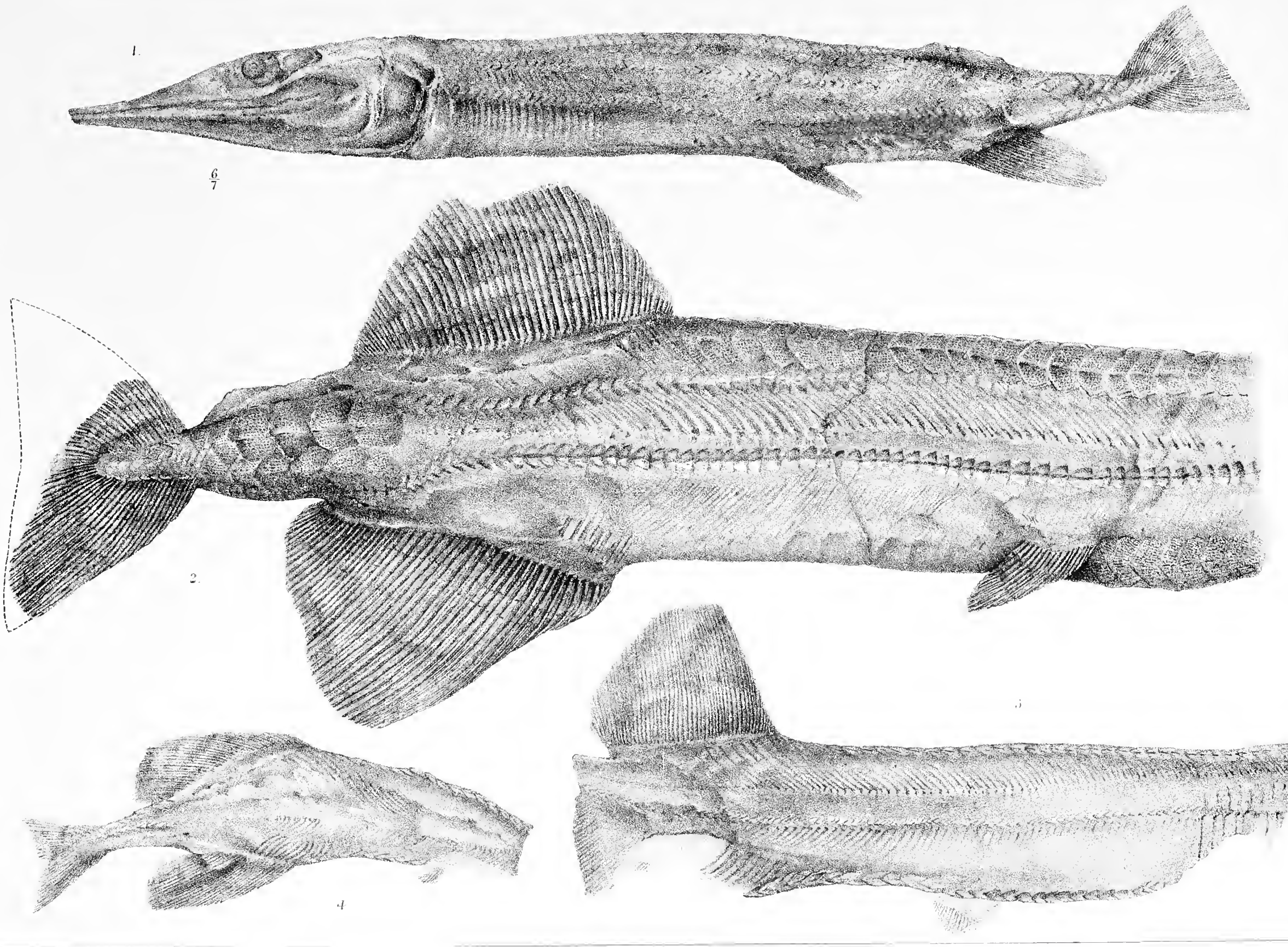

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BELONORHYNCHUS.

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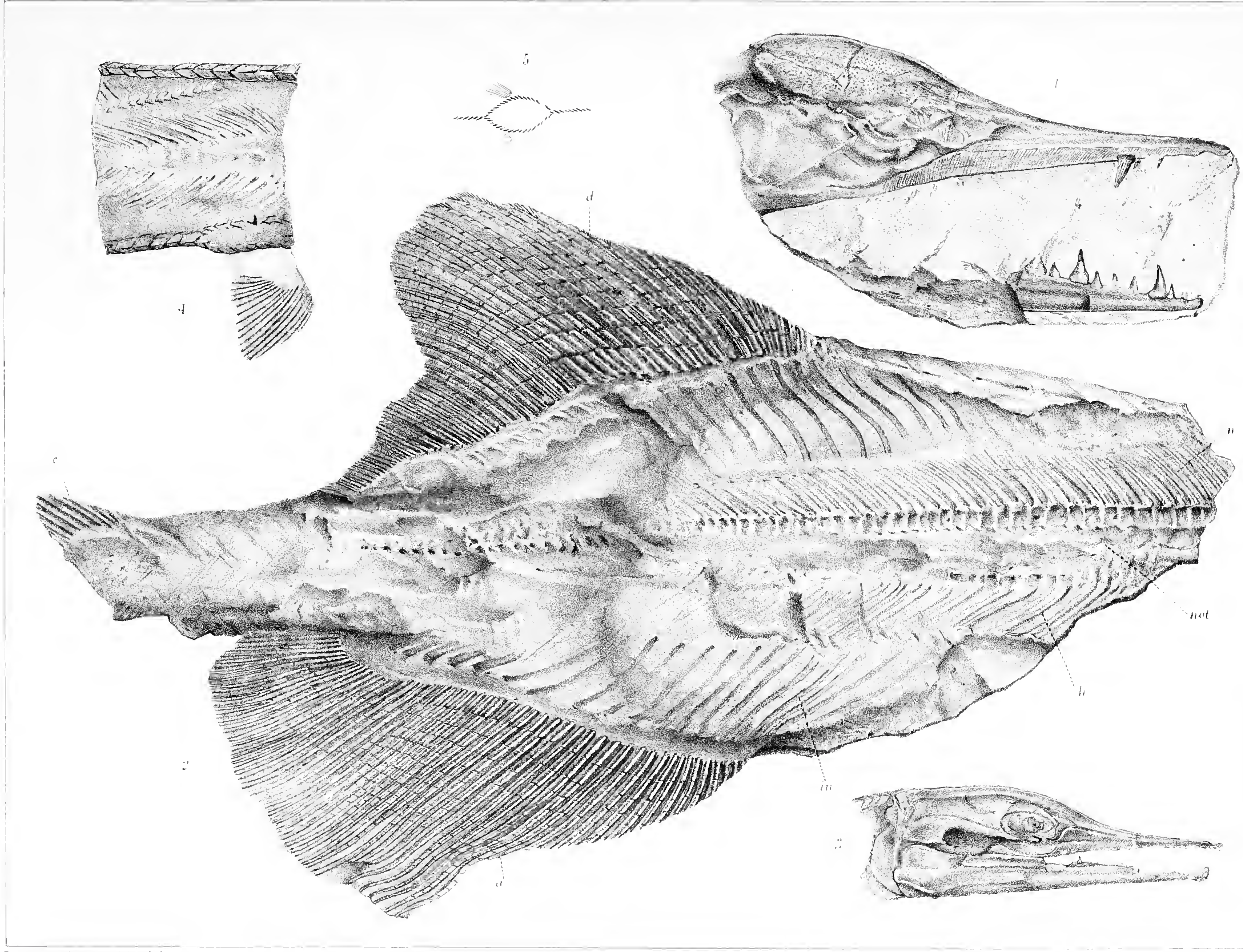

Pegeatt & Higgins, del et lith.

Chr. Sam. Bros., imp.

BELONORHYNCHUS.

DEPARTMENT OF MINES.

MEMOIRS OF THE GEOLOGICAL SURVEY OF NEW SOUTH WALES.
C. S. WILKINSON, F.G.S., &c., GEOLOGICAL SURVEYOR-IN-CHARGE.

PALÆONTOLOGY, No. 5.
R. ETHERIDGE, JNR., PALÆONTOLOGIST.

A MONOGRAPH

OF THE

CARBONIFEROUS AND PERMO-CARBONIFEROUS INVERTEBRATA

OF

NEW SOUTH WALES.

PART I.—CŒLENTERATA.

BY

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ISSUED BY DIRECTION OF THE HON. SYDNEY SMITH, M.P., MINISTER FOR MINES AND AGRICULTURE.

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MEMOIR.

LIST OF PLATES.

Letter of Transmittal.

Department of Mines,
Geological Survey Branch,
4 February, 1891.

Sir,

I have the honor to transmit the accompanying Memoir, No. 5, of the *Palæontological Series* of the Geological Survey of New South Wales, on the *Carboniferous and Permo-Carboniferous Invertebrata of New South Wales:* Part I, *Cœlenterata*, by Mr. Robert Etheridge, Junr., Palæontologist.

The Palæontology of the coal-bearing formations of New South Wales is a subject of much importance, not only from a purely scientific aspect, but also as bearing upon the economic development of the greatest of the mineral resources of the Colony—Coal. It is with this object in view that the attention of the Palæontologist has been primarily devoted to the subject.

Previous palæontological researches in this direction were largely based upon the fossils collected by the late Rev. W. B. Clarke, M.A., F.R.S. The descriptions given in this Memoir are chiefly of specimens in the collections recently made by the Officers of the Geological Survey, and now in the Mining and Geological Museum. These Departmental Collections are of special value for reference, not only because the Clarke Collections have been lost in the Garden Palace fire, but also as illustrating the life-history of the coal formations in the Hunter River District, the survey of which Mr. T. W. E. David, B.A., F.G.S., Geological Surveyor, is at present engaged upon.

It is interesting to note that the Class Actinozoa herein described by Mr. Etheridge shows a remarkable diminution in the Carboniferous and Permo-Carboniferous times, as compared with its high state of development in the Siluro-Devonian Period. This may be due to the physical changes which took place at the close of the latter period in this portion of the globe, and of which we have evidence in the deposition of a considerable thickness of arenaceous beds upon the massive Siluro-Devonian coralline limestones of our western districts, as near Molong. Moreover, the almost entire absence of any forms of coral life from the Lower Marine Series may, as suggested by Mr. David, have been due to the enormous development of tuffs in the Rhacopteris and Lepidodendron beds which form the upper portion of the preceding formation. Then, again, though the occurrence of striated boulders in the conglomerates of the Upper Marine Series points to deposition in which ice action has been concerned, the comparative abundance of certain genera of corals in several horizons in the Series is evidence of the sea at the time having been comparatively warm, and is opposed to any theory as to a general refrigeration of the Antarctic Ocean in this part of the Permo-Carboniferous Period.

The accompanying table of classification of the different series of the Permo-Carboniferous must to some extent be considered as provisional, and thus indicates how large a field awaits systematic geological survey and palæontological investigation.

I have the honour to be,
Sir,
Your obedient servant,
C. S. WILKINSON,
Geological Surveyor-in-Charge.

Harrie Wood, Esq., J.P.,
Under Secretary for Mines.

AUTHOR'S PREFACE.

THE present Part is the first of a Monograph of the Carboniferous and Permo-Carboniferous Invertebrata of New South Wales, contained in the Mining and Geological Museum of the Department of Mines, Sydney. It includes the whole of the Cœlenterata at present existing therein, but a few additional specimens have been obtained from outside sources, and will be suitably acknowledged later on. It is intended to issue the succeeding Parts as time and the state of the Collection will permit.

In the preparation of the descriptions I have frequently taken advantage of the valuable local knowledge and assistance of my colleagues, Mr. C. S. Wilkinson, L.S., &c., the Geological Surveyor-in-Charge, and Mr. T. W. Edgeworth David, B.A., Geological Surveyor.

To Mr. John Waterhouse, M.A., Inspector of Schools, I am under great obligations for the kind manner in which he has always striven to advance the objects of this work, by unreservedly placing his Collection at my disposal, and information at all times kindly supplied.

The Corals herein described have been obtained under the direction of Mr. C. S. Wilkinson, partly by Mr. Charles Cullen, Collector to the Geological Survey, and partly under the supervision of Mr. T. W. E. David, whose Geological Survey of the Maitland District embraces some of the particular coral-bearing beds described in this Memoir; but thanks are also due to the Rev. W. H. Yarrington, M.A., Dr. Morson, Mr. S. Dodds, and Mr. D. A. Porter, for specimens given or lent; whilst the section-cutting has been satisfactorily performed by Mr. Charles Murton, of the Geological Branch. I have also derived great assistance from a collection of Tasmanian *Stenoporæ*, partly collected by Mr. W. Anderson, Geological Surveyor, and partly supplied by my friend Mr. R. M. Johnson, Government Statist of Tasmania. To my colleague Mr. G. H. Barrow, of the Australian Museum, I am greatly indebted for the patience and skill displayed in the preparation of the original drawings, from which the plates have been heliotyped at the Government Printing Office by Mr. A. E. Dyer, under the direction of the Government Printer.

R. ETHERIDGE, JNR.

Sydney, March, 1891.

I.—INTRODUCTION.

The Fossils described in the present Monograph are those from the marine beds of the Carboniferous and Permo-Carboniferous rocks of N. S. Wales, the former lying below and separated by an unconformity from the latter, which are intercalated with the productive Coal-Measures. The distribution and general features of these strata will be described and their relations discussed in a forthcoming Memoir[1] by Mr. T. W. Edgeworth David, B.A.; but, with the view of rendering the stratigraphical value of the fossils in question as apparent as possible, a generalised classification of the above rocks will be found a few pages on. The Invertebrate Palæontology of the beds lying unconformably above the productive Coal-Measures has already been published.[2]

Four systematic descriptions of New South Wales fossils, coming within the scope of the present work, have already appeared, by Messrs. Morris and Lonsdale, M'Coy, Dana, and De Koninck, respectively. To the late Prof. John Morris and William Lonsdale belongs the honour of first systematically describing the Permo-Carboniferous and Coal-Measure fossils of New South Wales—those collected by the veteran explorer of Tasmania and Gippsland, Count Paul E. de Strzelecki, &c., who in 1845 published his "Physical Description of N. S. Wales,"[3] a work which may be described as the stepping-stone to Australian Geology. Prof. M'Coy's Memoir, published in the year 1847,[4] was a description of the earliest collections of the late Rev. W. B. Clarke, M.A., F.R.S., and generally bore out in a marked degree the conclusions arrived at by Morris. The third collection described was that made by the venerable Prof. James Dwight Dana, when acting as Naturalist and Geologist to the United States Exploring Expedition under Commander Charles Wilkes, U.S.N., between the years 1838–1842. The fossils in question are described in the magnificent volume of the expeditionary series devoted to its geological results.[5] The last series of organic remains referred to were described by the late Prof. Guillaume Laurient de Koninck, M.D., &c., in the "Mémoires de l'Académie Royale de Belgique"[6]; and again

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[1] Geology of the Maitland District, with special reference to the Coal-Measures, 4to. (in preparation).

[2] "The Invertebrate Fauna of the Hawkesbury-Wianamatta Series, &c.," pp. 21, 2 plates, Mem. Geol. Survey, N. S. Wales, Pal. Series, No. 1, (4to. Sydney, 1888). By R. Etheridge, jun.

[3] Physical Description of New South Wales and Van Diemen's Land, accompanied by a Geological map, sections, and diagrams, and Figures of the Organic Remains, pp. 462, plates, &c. (8vo. London, 1845). By P. E. de Strzelecki.

[4] "On the Fossil Botany and Zoology of the Rocks associated with the Coal of Australia," Ann. Mag. Nat. Hist., 1847, XX, pp. 145–157, 226–236, 298–312, Pls. 9–17.

[5] United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842, under the Command of Charles Wilkes, U.S.N., Vol. X, Geology, by J. D. Dana, pp. 756, Atlas, Pls. 21 (4to. and folio, Philadelphia, 1849.)

[6] "Recherches sur les Fossiles paléozoïques de la Nouvelles Galles du Sud (Australie)," pp. 373 and Atlas. Mém. Acad. R. Belgique (8vo. and 4to., Bruxelles, 1876–77).

to the exertions and liberality of the late Mr. Clarke we are indebted for the appearance of this great advance in the Science of Palæontology in N. S. Wales. Most of the Strzeleckian fossils described by Morris and Lonsdale are now in the Natural History Museum, London; the original collection made by Mr. Clarke, and described by M'Coy, is deposited in the Woodwardian Museum, Cambridge, England; Dana's gatherings, procured during the Wilkes' Expedition, were placed in the Smithsonian Institution, Washington, and subsequently burnt[1] some years ago; whilst the most complete series of the whole, the second Clarke Collection, was, as is well known, destroyed in the Garden Palace fire in Sydney, in 1882. From this it will be seen that we do not possess in N. S. Wales, nor in Australia for the matter of that, either of the old Collections, containing the original types on which the larger portion of our Palæozoic Palæontological nomenclature depends. This is most unfortunate, more especially as regards the series described by De Koninck, for so many of the species were diagnosed on single, and in some cases imperfect examples, that it is now very difficult to recognize them. Besides the collections here particularised, there have been, of course, from time to time, small sets of fossils described in occasional communications to learned Societies, which need not be further referred to at present; but before closing this Introduction, it may be well to mention the few fossils described by J. de Carle Sowerby in Mitchell's "Three Expeditions into the Interior of Eastern Australia,"[2] and collected by that Explorer at the outset of his First Expedition in the Hunter River District. These are now deposited in the cabinets of the Geological Society of London.

From the above circumstances, it is intended, in this and succeeding Parts, to describe only those species which come directly under the Author's notice as a portion of the Departmental Collection in the Mining and Geological Museum, or as contributed by private Collectors in illustration of the subject, leaving all others described by previous Writers, and not represented, to testify for themselves. With the view of doing every justice to the series described by Prof. de Koninck, a translation of his "Recherches," as literal as possible, will shortly be published as one of the Memoirs of the Geological Survey.

The general geological subdivisions of the Carboniferous and Permo-Carboniferous rocks of N. S. Wales, as at present understood by the Geological Survey, are as follows :—

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[1] I was so informed by Prof. J. D. Dana.

[2] Three Expeditions into the Interior of Eastern Australia, with Descriptions of the recently-explored Region of Australia Felix and the present Colony of New South Wales, I, p. 15. (2 vols., 8vo., London, 1838.)

The Carboniferous and Permo-Carboniferous Formations of N. S. Wales.

		Hunter River Coal-field.	Illawarra Coal-field.	Blue Mountain and Lithgow Coal-field.	Mittagong Coal-field.	Gunnedah or Namoi Coal-field.
PERMO-CARBONIFEROUS.	Upper Coal-Measures	*Newcastle Group.* Productive Coal-Measures, with *Glossopteris*, &c.	*Bulli Group.** ditto	*Lithgow Group.** ditto	*Mittagong Group.** ditto	*Namoi Group.** ditto
PERMO-CARBONIFEROUS.	Upper Coal-Measures	*Dempsey Group.* Barren fresh-water beds.	(Unproven.)	(Unproven.)	(Unproven.)	(Unproven.)
PERMO-CARBONIFEROUS.	Middle Coal-Measures	*Tomago, or East Maitland Group.* Productive Coal-Measures, with *Glossopteris*, &c.	(Unproven.)	(Unproven.)	(Unproven.)	(Unproven.)
PERMO-CARBONIFEROUS.	Upper Marine Series	1. Mulbring beds. 2. Muree Rock. 3. Branxton beds, with erratics.	1. Encrinital Shales. 2. Nowra Grit. 3. Conjola beds.	Wallerawang beds.		
PERMO-CARBONIFEROUS.	Lower Coal-Measures	*Greta Group.* Productive Coal-Measures, with *Glossopteris*, *Vertebraria*, &c.	*Clyde Group.* ditto	(Hidden by overlap.)	(Hidden by overlap.)	(Hidden by overlap.)
PERMO-CARBONIFEROUS.	Lower Marine Series ...	*Farley Group.*	(Unproven.)	(Unproven.)	(Unproven.)	(Unproven.)
		Unconformity?	*ditto*	*ditto*	*ditto*	*ditto?*
CARBONIFEROUS ...		1. Rhacopteris beds. 2. Marine beds, with *Productus*, *Conularia*, &c. 3. Rhacopteris and Lepidodendron beds.	(Unproven.)	Rhacopteris and Lepidodendron beds.	(Unproven.)	Lepidodendron beds of Goonoo Goonoo.
		....	....	*Unconformity?*	....	....
DEVONIAN		....	....	Mt. Lambie Sandstones and Quartzite.	....	....
SILURIAN		....	Yalwal Slates.	....	Marulan Limestone.	....

* This classification is provisional; the Group may have to be classed with the Middle Coal-Measures.

The classification formerly adopted by various authors was the subdivision of our New South Wales rocks immediately above the Devonian into Lower Carboniferous, Carboniferous, and Permian; or simply Carboniferous and Permian. Recent palæontological investigations will probably lead to a modification of this classification, in so far that the whole of the beds below the Lower Marine Series may be regarded as more truly allied to the Carboniferous simply. On the other hand, that series and the beds above, viz., the Upper Marine and the whole of the Coal-Measures, having an affinity with both Permian and Carboniferous, might be termed the Permo-Carboniferous. The facts in detail, for the support of this view, are still under consideration, and not sufficiently matured for publication, but they appear to tend in the direction indicated. At the same time great caution must be exercised in assimilating our geological subdivisions strictly with those of the old world.

It is impossible, in the following pages, to minutely define the distribution of our uppermost Palæozoic Coral-fauna, simply from our want of knowledge regarding the horizons yielding corals at several localities, such as in the Paterson, Williams, and Rouchel Brook Districts. Mr. C. S. Wilkinson informs me that these are probably localities within the Carboniferous area, or as it would have been termed formerly the Lower Carboniferous. Presuming this to be the case, then we have here the first development of coral life above the Devonian, and it was a moderately copious one. In the Lower Marine Series, however, there would appear to be, so far as our present knowledge enables us to judge, a very considerable falling off, but in the Upper Marine Series corals again make their appearance, comprising several very interesting forms.

II.—DESCRIPTION OF THE GENERA AND SPECIES.

Sub-kingdom—CŒLENTERATA.

Class—ACTINOZOA.

Obs.—One of the most remarkable features in connection with the Permo-Carboniferous Fauna of New South Wales is the great numerical and specific development attained by certain groups of animal life, to the marked, although not total exclusion of others. In no class is this more apparent than the present. In extra-Australian areas, more particularly Europe, side by side with a teeming Molluscan life, a moderately prevalent Crustacean, and a vigorous development of Echinodermata, we find the remains of an equally prevalent Coral fauna during the Carboniferous.

On the other hand, during an equivalent period in New South Wales, and indeed throughout Australia generally, the Actinozoa dwindled to a comparatively insignificant factor. That this was not the case in Præ-Carboniferous times is quite apparent, as a glance at the rich Coral fauna of the Silurian and Siluro-Devonian rocks of this Province will show.

Should future researches support this view, we can only adopt the conclusion that coral life at this particular period, in what is now New South Wales, was gradually dwindling, as it also did during the closing epoch of the Palæozoic Period in other quarters of the globe.

The remains of corals, even when recorded, have been but indifferently preserved and scanty in numbers. This seems to hold good in all cases, except those of the genera *Stenopora*, representing the Monticuliporidæ, and

Zaphrentis, indicating the great group of the Rugosa. At a few localities they have been met with, not in specific abundance, but in a plenitude of individuals. Equally does this statement hold good for the Permo-Carboniferous of Queensland, and I believe for Tasmania also. So little is, however, known of the fossiliferous contents of the thick limestones of Western Australia that such a generalisation cannot be applied to that Province at present.

A glance at the results attained by the four principal workers in the Palæozoic Palæontology of Eastern Australia, during the forty-five years which have elapsed since Lonsdale wrote, will impress this question strongly on the mind of the reader. Lonsdale,[1] in 1844, described the new genus *Stenopora* and four species from New South Wales and Tasmania, afterwards recapitulating these, and adding a rugose coral, *Amplexus arundinaceus*.[2] The last named and two of the foregoing species of *Stenopora* were quoted by M'Coy[3] in 1847, and three other corals added, one being a new genus and species, *Cladochonus tenuicollis*. Passing on to the researches of Dana, we find that he merely localised Lonsdale's *Stenoporæ* and added a fifth species, but under the name of *Chætetes gracilis*.[4] Lastly we come to the work of the late Prof. L. G. de Koninck, by whom the collections of the late Rev. W. B. Clarke were classified and described. De Koninck,[5] as well as reviewing many of those already referred to, added thirteen species to the Australian Permo-Carboniferous Coral Fauna, appertaining to seven genera, not previously described as coming from that horizon. Omitting one of De Koninck's species (*Lithostrotion basaltiforme*) from the Murrumbidgee,[6] the total gives us nine genera and twenty-one species recorded during the long period in question, but the species may be reduced to twenty by the elimination of one of Prof. M'Coy's, viz., *Turbinolopsis bina*, probably determined on the internal cast of a Zaphrentoid coral. Of the genera, two were specially established for the reception of their species.

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[1] Darwin's Geol. Obs. Volc. Islands, 1844, p. 161, note.

[2] Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 262.

[3] "On the Fossil Botany and Zoology of the Rocks associated with the Coal of Australia," Ann. Mag. Nat. Hist., 1847, XX, pp. 226 and 227.

[4] United States Exploring Expedition, during the years 1838–42, under the command of Charles Wilkes, U.S.N. Vol. X, 1849, Geology by J. D. Dana, p. 712 (4to. and folio, N. York, 1849).

[5] Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 143.

[6] There are no Permo-Carboniferous rocks on this river. The coral in question occurs in the Cave Limestone, at Cave Flat, on the Murrumbidgee, south-west of Bowning, and it is questionable if it be a *Lithostrotion* at all. The Cave Limestone is either Upper Silurian or Siluro-Devonian.

Order—ZOANTHARIA.

Sub-order—Z. **Sclerodermata.**

Section A—RUGOSA.

Group—ZAPHRENTOIDEA.

Family—*ZAPHRENTIDÆ.*

Obs.—The late Prof. de Koninck described one doubtful species of *Zaphrentis* as *Z. Phillipsi*, Ed. and H.,[1] and a *Lophophyllum, L. minutum*,[2] which have not come under my notice. The *Zaphrentis* may possibly be identical with a species I have later on called *Z. Culleni.*

As *Strombodes? australis*, Prof. M'Coy described[3] a coral in 1847 having some points in common with genera placed in this family. He says it is without transverse chambers (? tabulæ), and the septa twisted about the centre are grouped in irregular bundles. The appearance presented by his figure is certainly that of a Zaphrentoid coral, and this is borne out by the grouping of the septa, but the twisting of the latter, unless it be in a loose and irregular manner, and the absence of tabulæ do not assist in bearing out this supposition. Through some unaccountable error I formerly referred[3] this coral to *Lonsdaleia*, a mistake I now wish to correct.

Genus—AMPLEXUS, *J. Sowerby.*

(Min. Con. I, p. 165.)

AMPLEXUS, *sp. ind.*

Pl. IX, Fig. 10.

Obs.—It will be shown below that the fossil usually known under the name of *Amplexus arundinaceus*, Lonsd., does not appertain to that genus, but a small and apparently undoubted species does exist in our Carboniferous Series (Pl. IX, Fig. 10). The specimen is unfortunately too imperfect for

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[1] Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 149.
[2] *Ibid*, p. 147, t. 5, f. 5.
[3] Cat. Austr. Foss., 1878, p. 37.

detailed description, but it is evident that the septa were short, after the type of the genus, and about twenty in number; the tabulæ close, about half a line apart; and the corallum conical and curved at the base.

Locality and Horizon.—Pallal[1] (¾ mile S.W. of), Horton River, Co. Murchison (*C. Cullen*):—Carboniferous.

Genus—ZAPHRENTIS, *Rafinesque and Clifford*, 1820.

(Ann. Sci. Phys. Bruxelles, V, p. 234.)

Obs.—Dr. G. J. Hinde has recently described a genus of West Australian corals from the Carboniferous as *Plerophyllum*,[2] to take the place of De Koninck's *Pentaphyllum*, previously occupied. The essential characters of his genus are,—(1) the extra-development of four or five prominent septa; (2) the infilling of the interlocular spaces and centre of the corallum with successive layers of stereoplasma; and (3) the presence of a thick outer wall consisting apparently of the coalesced parietal margins of the septa with an outer epithecal layer. The second and third characters are highly developed in our N. S. Wales Zaphrentoid corals, and could I have satisfied myself of the preponderance of four or five septa over the others, in the manner shown in Dr. Hinde's figures, I should unhesitatingly have adopted his genus; but such does not appear to be the case, although there is, as explained in the specific descriptions, an undoubted grouping of the septa, usually into four bundles. In the meantime, I shall content myself by publishing our species with the additional name of *Plerophyllum*, placed after that of *Zaphrentis*, with the view of drawing attention to their close affinity to the latter. On the other hand, if our species are distinct from the absence of these specialised septa, and equally separated from Zaphrentis by the stereoplasmic deposit (well shown in our Pl. VIII, Figs. 7 and 16), which appears to completely fill the lower portions of the corallum with solid tissue, they may, perhaps, in the future be known under the name of *Hemizaphrentis*. This heavy deposit of stereoplasma to some extent allies the present corals to *Lindströmia*, Nicholson and Thomson,[3] in which "the lower portion of the visceral chamber (is) often more or less completely filled up by the deposition within it of solid

[1] This locality was described by the late Samuel Stutchbury in his "Tenth Tri-monthly Report on the Geological and Mineralogical Survey of N. S. Wales" (N. S. Wales Leg. Council Papers, 1853, No. 235 A, pp. 9—Sydney, fcap., 1853), p. 6, and wherein he gave a list of about thirty species of fossils found there. The horizon is at present doubtful.

[2] Geol. Mag., 1890, VII, p, 195.

[3] Proc. R. Soc. Edinb., 1876, IX, No. 95, p. 149.

sclerenchyma."[1] On the other hand, *Lindströmia* possesses a pseudo-columella of peculiar structure, but no septal fossula, and is therefore clearly distinct from the present forms.

ZAPHRENTIS (PLEROPHYLLUM ?) ARUNDINACEUS, *Lonsdale, sp.*

Pl. VIII, Figs. 1 and 2; Pl. IX, Figs. 11–13.

Amplexus arundinaceus, Lonsdale, in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 267, t. 8, f. 1.

" " De Koninck, Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 149.

Sp. Char.—Corallum long, cylindro-conical,[2] oval in section. Septa thirty-six, in the calice longer on the dorsal side, curving but little, moderately thick towards the periphery, uniting sub-centrally to form a large septal fossula on the ventral side, coated with stereoplasma; dissepiments very scanty and quite marginal, in one or two cycles; septal fossula large, but not deep, containing one counter septum. Tabulæ well marked, nearly flat or slightly convex upwards, the septa ill-defined thereon, and extending about one-third across; fossula small and shallow, represented on the under surface of each tabulum by a small elongated projection. Epitheeal characters unknown.[3]

Obs.—The above description includes certain corals believed to be Lonsdale's *Amplexus arundinaceus*, but his imperfect description must obviously leave the question open to doubt. This might be solved by an appeal to the type now in the Geological Department, Natural History Museum, London, but if my memory does not deceive me this is not in too good a state of preservation either. The late Prof. de Koninck suggested the removal of this species to the genus *Zaphrentis*, a proposition now adopted, and to which he was probably led by the following passage in Lonsdale's remarks:—"Converging radii were traced from nearly half the periphery of the oval across more than two-thirds of the area." In *Amplexus* the septa are usually little more than mere marginal crenulations, but the remarkable manner in which they are developed in the calice of the present species renders its transfer to *Zaphrentis* necessary. Lonsdale's observation that the "crenulations near the margins of the septa or diaphragms were unequal in

[1] Nicholson and Etheridge, Junr., Mon. Sil. Foss. Girvan in Ayrshire, 1888, Fas. 1, p. 80.
[2] De Koninck says more or less curved at the base.
[3] Lonsdale describes the exterior as longitudinally ribbed, and transversely annulated, and is supported in this statement by De Koninck.

range as well as strength, and in some cases they were scarcely detectable," clearly refers to the septa on the tabulated portions of the corallum, and not in the calice, the structure of these two portions of the coral differing considerably, as will be seen from the specific description given above.

I am under the impression that Lonsdale's figure represents a specimen inverted, the apparent tabular boss being in fact the downwardly projecting septal fossula, similar to that represented in our Pl. VIII, Fig. 2, and Pl. IX, Fig. 13. Its excentric position bears this out.

Locality[1] *and Horizon.*—Jervis Bay, Shoalhaven District, Co. St. Vincent (*C. Cullen*); Shoalhaven Heads, ditto (*C. Cullen*) :—**Upper Marine Group.**

ZAPHRENTIS (PLEROPHYLLUM ?) CAINODON, *De Koninck.*

Pl. VIII, Figs. 13–16.

Zaphrentis cainodon, De Koninck, Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 151, t. 5, f. 8, 8*a*.

Sp. Char.—Corallum cylindro-conical, long, rather curved, gradually tapering, and of somewhat irregular habit from unequal growth accretions, pointed at the base; section generally oval. Calice deep, open. Septa forty to forty-two in number, thickened by a deposition of stereoplasma, which unites to form a coalesced mass on the dorsal side; dorsal septa slightly shorter and straighter than the ventro-lateral, which are curved, and unite in two groups to surround a septal fossula, which reaches to the centre of the calice, and contains from one to three counter septa of variable length; cardinal septum not apparent; dissepiments moderately well developed on the ventral side, and generally irregular in their arrangement; dissepimental vesicles, some oval, some triangular, but usually irregularly developed. Tabulate area small, tabulæ immediately below the calice vesicular. Rugæ appear to be simple both on dorsal and ventral sides; epitheca not preserved, but probably thin.[2]

Obs.—This species generally resembles the next to be described, *Z. gregoriana*, but is much longer and proportionately larger, the calice rounder in section, and the relative increase in diameter within a given space much less. Lastly, the septa are more numerous, and the septal fossula shorter.

[1] Other localities recorded are—Barber's, Barber's Creek, and Amprier, near Glenrock, Co. Argyle (*Strzelecki*); Shoalhaven District (*Strzelecki*); Curradulla. or Limestone Creek, ? Co. Argyle (*M'Coy, Ann. Mag. Nat. Hist.*, 1847, XX, p. 228); Colocolo (*De Koninck*).

[2] De Koninck describes the epitheca as probably thin and smooth.

Z. cainodon is the longest of the smaller species of our *Zaphrentis*, one example measuring three and a half inches in length.

The form of this coral is decidedly more Amplexiform than it is Zaphrentoid; but the convergence of the septa to the centre and presence of dissepimental tissue indicate its generic affinities. The primordial laminæ of the septa are always distinct in the specimens which I have examined, although surrounded by much stereoplasma. The latter, on the dorsal side, at a short distance below the bottom of the calice, becomes fused into a consolidated mass, interseptal loculi being only visible on the ventral side of the corallum, and even then not many of them. This dense deposit of stereoplasma is well seen in a vertical section of the corallum (Pl. VIII, Fig. 16) taken from immediately below the calice of the individual specimen, and to some extent recalls the filling up of the corallum base in *Lindströmia*,[1] Nicholson and Thomson. The vesicular condition of the tabulæ immediately below the floor of the calice is also apparent.

Locality[2] *and Horizon.*—Jervis Bay, Co. St. Vincent (*C. Cullen*):—
Upper Marine Group.

ZAPHRENTIS (PLEROPHYLLUM ?) GREGORIANA, *De Koninck.*

Pl. VIII, Figs. 3-12; Pl. IX, Figs. 8 and 9 ?

Zaphrentis Gregoriana, De Koninck, Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 150 t. 5, f. 7.

Sp. Char.—Corallum of medium size, more or less cornute, but the curvature never great; section circular; base sharply pointed. Calice moderately deep. Septa thirty-six to thirty-eight, thickened at their proximal or basal ends by the deposition of stereoplasma, which unites to form a coalesced mass on the dorsal side, but the primordial septa remain distinct; the ventro-lateral groups curve upwards and inwards to surround a large septal fossula, which extends just to the centre of the calice, occupied by one or two counter septa; cardinal septum not apparent; dissepiments but little developed[3]; interseptal loculi elongated triangular spaces. Tabulate

[1] See Nicholson and Etheridge, Mon. Sil. Foss. Girvan in Ayrshire, 1878, Fas. I, p. 84, f. 4.
[2] De Koninck records this species from Burragood on the Paterson River.
[3] De Koninck says that the septa are united by irregular vesicles, especially in the outer part of the corallum, but I have not observed these.

area well marked but not large, diminishing much in size towards the base. Rugæ generally single on the dorsal side, bifurcate on the ventral; epitheca not preserved, but probably very thin; growth accretions present, but slight.

Obs.—De Koninck compared this species to *Zaphrentis cliffordana*, Ed. & H.; but it differs from the latter by the arrangement of the rugæ, and is much larger. The dissimilarity of the costæ on the ventral and dorsal sides distinguishes this species from most of the other Australian species. The want of resemblance to *Z. cainodon* is at once apparent; but those specimens which I have examined present a general similarity in the grouping of the septa.

In connection with this species some very interesting internal casts and external impressions may be referred to, especially as the number of septa and their grouping, form of the corallum, and position of the septal fossula are identical with those of *Z. gregoriana*. Both in the impression (Pl. IX, Fig. 9) and matrix surrounding the casts (Pl. IX, Fig. 8) the epitheca is seen to be pierced by a number of irregularly-arranged holes, varying in number and contiguity to one another in different specimens, although in some examples more closely set towards the upper portions of the corallum. These clearly represent epithecal out-growths, such as are met with in some species of *Zaphrentis*, *Amplexus*, &c. It is equally clear that the epitheca in these corals was thick, with moderately strong accretion swellings. On the other hand, we lack definite information as to the epithecal characters of *Z. gregoriana*, and the relation between these casts and the latter must, therefore, remain for the present unsolved.

In Pl. VIII, Fig. 7, is visible one of those peculiar processes springing from the floor of the calice, which have been so abundantly and excellently figured by Rudolph Ludwig in his Memoir, "Corallen aus paläolithischen Formationen," in figures of *Zaphrentis* and other genera, especially one termed by him *Cyathodactylia*.[1]

Locality[2] *and Horizon.*—Jervis Bay, Co. St. Vincent (*C. Cullen*): **Upper Marine Group.** The spinose casts are from Shoalhaven Heads and Copper Point, Shoalhaven River, Co. St. Vincent (*C. Cullen*):—**Upper Marine Group.**

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[1] Palaeontographica, XIV, Heft 4, t. 36 1b, 2b.
[2] De Koninck also mentions Colocolo

Zaphrentis (Plerophyllum?) Culleni, *sp. nov.*

Pl. IX, Figs. 1–7.

Sp. Char.—Corallum small, slender, and cornute in a greater or less degree, sometimes slightly turbinate; base sharp and pointed, at times slightly constricted and the extremity becoming appendage-like; growth accretions numerous at irregular distances apart, and sometimes ill-defined. Calice deep, circular; mouth probably horizontal, or strictly at right angles to the growth. Septa twenty-two to twenty-four, primary and secondary, the former large and passing to the centre, where they become lost on a small tabulum, the latter thorn-like, short, and peripheral; stereoplasma greatly developed; dissepiments apparently absent; fossula not distinguishable. Rugæ fine and regular, but to some extent obliterated by the regular epitheca, which is thick and concentrically striate.

Obs.—This little coral is very characteristic of the Rouchel Brook beds, and appears to be undescribed so far as Australian species are concerned. It is named after Mr. Charles Cullen, Collector to the Geological Survey, as an acknowledgment of his services in collecting material for the elaboration of this Memoir.

The form of the corallum in *Z. Culleni* varies from gently cornute to nearly straight, but one extreme case has been observed where the curvature of the corallum was acute (Pl. IX, Fig. 1). The base is always sharp, rendered so usually by a sudden diminution in size of the corallum, imparting to the base a minutely petiolate or appendage-like appearance. There is a well-marked epitheca which more or less obliterates the sharpness of the costæ. A considerable development of stereoplasma takes place around each septum individually, but on one side of the corallum this is much greater than the other, tending to obliterate many of the remaining features of the calice. Dissepiments appear to be wholly wanting, although loculi are left between the stereoplasmically-thickened septa; nor have I been able to detect a fossula with certainty.

The late Prof. de Koninck referred a single small coral from Colocolo to the well-known European species *Zaphrentis Phillipsi*, Ed. and H., with some doubt. The number of septa described in this specimen totally forbids its reference to the European form, and there is the possibility of its identity with the present species, *Z. Culleni.* I should have been inclined to refer the Colocolo coral to the latter had it not been for De Koninck's pointed reference to a fossula and grouping of the septa. On the latter hand, however, it may be remarked that a tendency to a grouping has come under my notice in more than one example of *Z. Culleni,* but the extensive development of stereoplasma has so far tended to obliterate structure that too much stress cannot be placed on this point.

Locality and Horizon.—Binge Berry, Rouchel Brook, Hunter River, Co. Durham (*C. Cullen*) :—Horizon doubtful, but perhaps Carboniferous. Pallal Station, Horton River, Co. Murchison (*C. Cullen*) :—Horizon ditto. Torryburn, Logan's Station, twelve miles from Parteson, Co. Durham (*Rev. W. H. Yarrington, M.A., and J. Waterhouse, M.A.*) :—Horizon ditto.

ZAPHRENTIS (PLEROPHYLLUM ?) ROBUSTA, *De Koninck.*

Plate X, Figs 1–3.

Zaphrentis robusta, De Koninck, Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 152, t. 5 f. 9, 9*a*.

Sp. Char.—Corallum moderately large, turbinate, but little curved, and robust, with ill-defined growth accretions; proper wall very thick; section circular; base sharply pointed in the young state, obtuse when older. Calice wide and very deep, nearly equal to half the height of the corallum, the margin horizontal. Septa forty-five, slightly curving on their inward course, not extending to the centre, which is tabulate, except at the base, divided into four groups, the two dorsal containing nine in each, the ventral seven; counter septa two; cardinal septum strong, extending to the dorsal edge of the fossula; alar septa strong and obliquely curved; stereoplasma not highly developed; fossula pyriform, ventral, at the base extending to the centre; dissepiments small, and not numerous; interseptal loculi as long oval-pyriform spaces. Tabulate area moderately large, flat. Rugæ simple, obtuse, and inconspicuous. Epitheca strong and thick, forming short imbricating frills over the rugæ.

Obs.—According to the late Prof. de Koninck this is distinguished from all the preceding species by its turbinate form, large proportional diameter of its calice, and thickness of the epitheca, features I am able to confirm after an examination of some specimens collected by Dr. Morson and Mr. J. Waterhouse, M.A., in the Maitland District. To these may be added the arrangement of the septa, and the fact that the peripheral edge of the calice is horizontal.

The corallum is, generally speaking, straight, and only curved, to any great extent, at its immediate base. The epitheca is thick and dense, and covers the costæ in concentric laminar frills. The present examples exceed those described by De Koninck in size—one being two and a quarter inches in height, by one and a quarter in breadth across the calice, and another one and three-quarter inches in height, with a greatest diameter of one and a half inches. Our examples possess forty-five septa, De Koninck only quoted thirty-six, but I nevertheless feel satisfied that the forms are the same species, they otherwise so closely correspond.

Locality[1] *and Horizon.*—Branxton, on the Hunter River, Co. Northumberland (— *Morson, M.D.*). Near Dee's Hotel, West Maitland, Co. Northumberland (*J. Waterhouse, M.A.*) :—**Upper Marine Group.**

ZAPHRENTIS PHYMATODES,[2] *sp. nov.*

Plate IX, Figs. 14–17.

Sp. Char.—Corallum of medium size, turbinate-conical, very slightly curved, with inconspicuous growth accretions; section circular; base slightly curved. Septa forty-eight, irregularly grouped in bundles, which meet at, and become lost on, a small central tabulate area; stereoplasma largely developed, forming a solid peripheral zone, extending inwards for from one-third to half the diameter of the corallum, and afterwards enclosing each septum, leaving between them elongate and irregular interseptal loculi; dissepiments not apparent; fossula lateral[3]; alar septum short. Tabulate area small. Rugæ hid by the epitheca, which is strong, thick, and corrugated, with very numerous tubular out-growths over the whole corallum, and roughly arranged in quincunx.

Obs.—*Z. phymatodes* is a peculiar species, both in its septal and epitheeal characters. On the ventral, or side of the least curvature of the corallum, the septa are united in irregular bundles. The peripheral mass of

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[1] De Koninck mentions Burragood.
[2] Φωματώδης, abounding in tubercles.
[3] *i.e.*, on the left-hand side of the observer.

stereoplasma forms a more or less solid zone, but in the space between it and the tabulæ the septa are separate, and there are long irregular loculi. I am unable to distinguish any definite dorsal or ventral fossula, but there is a left lateral one containing a short and rather stout alar septum.

As regards the epitheeal characters, a spinose or tubercled epitheca is not unknown in the Zaphrentidæ, but in the present instance this structure of the exoskeleton is developed to a greater extent than usual. It is also more common in *Amplexus* and its allies than in *Zaphrentis*. For instance, spines exist in *Amplexus spinosus*, De Koninck[1], and are confined to the base of the corallum; and in *A. lacrymosus*, De Koninck[2], where they are generally scattered over the surface. Other corals also possess these structures, such as *Axophyllum radicatum*, De Koninck[3], and *Pentaphyllum armatum*, De Koninck[4], from the European Carboniferous. We also possess an Australian species, already described, furnished with similar excrescences, and there is *Amplexus pustulosus*, Hudleston[5], from the neighbourhood of the Gascoyne River, Western Australia. Of the species cited, however, the greatest resemblance exists between *Axophyllum radicatum* and our species. In the latter these out-growths are tubular, but broken off short, and have every appearance of having been used as anchoring stolons.

It may be conjectured that *Z. phymatodes* is related to the spinous form described under *Z. gregoriana*, but the dissimilarity in the number of the septa and position of the fossula will at once dispel any pre-conceived view of this matter. I believe the two corals to be quite distinct.

Locality and Horizon.—One mile south-east of Mulbring, near West Maitland, Co. Northumberland (*C. Cullen*):—**Upper Marine Group.**

ZAPHRENTIS ? SUMPHUENS[6], *sp. nov.*

Plate XI, Figs. 4–6.

Sp. Char.—Corallum of medium size, conical, curved. Septa forty-four, with an equal number of secondary lamellæ; the primary septa are long, flexuous, reaching nearly to the centre of the corallum, and grouped in

[1] Nouv. Rech. Anim. Foss. Terr. Carb. Belgique, 1872, Pt. I, p. 75, t. 6, f. 6.
[2] *Loc. cit.*, p. 76, t. 6, f. 7.
[3] *Loc. cit.*, p. 24, t. 1, f. 3.
[4] *Loc. cit.*, p. 59, t. 4, f. 8.
[5] Quart. Journ. Geol. Soc., 1883, XXXIX, t. 23, f. 1–1c.
[6] *συμφύω* to make coalesce.

four principal bundles, two dorsal and two ventral; in the centre of the corallum certain of the principal septa meander and coalesce to enclose a series of large open vesicles; an outer narrow, but well-marked, vesicular zone exists, beyond which the secondary septa do not proceed, and in which the primary septa are not enveloped in stereoplasma; dissepiments fine and fairly regular; stereoplasma thickly enveloping the septa from the margin of the outer vesicular zone to the edge of the central vesicles; loculi in the outer zone more or less rhomboidal, when confined by stereoplasma very long and narrow, following the curve of the septa; fossula indistinctly marked, but apparently lateral, with one secondary alar septum.

Obs.—The septa in this species are very irregularly grouped, but there would appear to be four chief sets. The coalescing of the bundles by means of six or seven of the primary septa is very marked, and results in the enclosure of several large vesicles or spaces filled with clear calcite. One of these septa, possibly corresponding to the ventral counter septum, passes directly across the centre, uniting with another which may represent the cardinal septum. I have not observed any trace of a tabulate area. The loculi confined between the septa when thickened with stereoplasma are particularly long and narrow, and at times subdivided by very minute dissepiments at long intervals apart. The section of this coral resembles in many ways that of *Z. patula*, Michelin, as figured by Thomson[1], more particularly as regards the central vesicular space.

Locality and Horizon.—Somerton, near Tamworth, Co. Parry (*D. A. Porter*):—Horizon doubtful, but in the Upper Marine Series.

Genus—LOPHOPHYLLUM, *Edwards and Haime*, 1850.

(Mon. Brit. Foss. Corals, Introd., 1850, p. lxvi.)

Obs.—Two species of *Lophophyllum* were described by Prof. De Koninck as existing in the Clarke Collection. One of these, *L. minutum*, De Kon.[2], has not come under my notice; the other, *L. corniculum*, or at any-rate a coral believed to be it, is described below.

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[1] Corals of the Carboniferous System of Scotland, 1883, t. 6, f. 12, 12*a*.
[2] Foss. Pal. Nouv. Galles du Sud 1877, Pt. 3, p. 147, t. 5, f. 5.

Lophophyllum corniculum, *De Koninck?*

Plate X, Figs. 7–9.

Lophophyllum corniculum, De Koninck, Foss. Pal. Nouv. Galles du Sud, Pt. 3, 1877, p. 148, t. 5, f. 6, *a* and *b*.

Sp. Char.—Corallum of medium size, conical, slightly curved, with fine-growth swellings; section circular; base pointed. Calice deep, with erect margins. Septa thirty-four to thirty-six, alternating with an equal number of secondary lamellæ; primary septa gently bent on themselves dorsally, straight ventrally, converging inwards towards, but not reaching the spurious columella; cardinal septum lamellar along its outer two-thirds, enlarging at its inner extremity in the centre of the calice, into a more or less lanceolate body; below the floor the dorsal, central, and probably ventral septa meet the thickened end referred to, and unite with it to assist in forming the so-called columella; counter and alar septa not diferentiated; fossula dorsal, very large and deep; dissepiments scanty and irregular, forming one or two cycles close to the periphery; vesicles irregular; loculi otherwise open and deep. Epithica thin with fine accretion marks, and delicately concentrically lined; rugæ fine, corresponding to the interseptal loculi.

Obs.—The specimens referred to this species depart from De Koninck's description in the position of the fossula, which is certainly dorsal, or on the side of the greatest curvature of the corallum, and not lateral, or variable. The remaining characters, however, are identical. De Koninck stated that in the corals examined by him the position of the fossula did not correspond to either of the curvatures of the corallum, but was situated sometimes to the right, at others to the left. In *Lophophyllum* the position of the fossula is generally described by authors as ventral, but in their original definition of the genus, Edwards and Haime do not lay down any special rule, and it may therefore vary in position generically, just as much as in *Zaphrentis*.

The position now assigned by writers to *Lophophyllum* is fully borne out by the structure of the Australian specimens. It was shown by Kunth[1] that the supposed columella is only the enlarged inner end of one of the principal septa, usually the counter septum, and not a columella in the true

[1] "Beiträge zur Kenntniss fossiler Korallen," Zeitsch. Deutsch. Geol. Gesellschaft, 1869, p. 193.

sense of the word. This is clearly shown in Kunth's figures of *Lophophyllum confertum*[1] and *L. leontodon*[2]. In the coral now under description, which is far larger than most of the European, the cardinal septum, towards the floor of the calice, expands into a thickened lanceolate body, towards which the dorsal septa converge, curving on themselves (Pl. X, Fig. 9). Still nearer the floor of the calice, the whole of the dorsal septa and some of the lateral unite with this body, which is much enlarged thereby; its connection with the cardinal septum is, however, still traceable. Below the calice floor, and near the base, the whole of the septa unite in the centre, and there seems to be a deposit of stereoplasma.

The secondary septa in our specimens (Pl. X, Fig. 8) are very apparent, although Prof. H. A. Nicholson says that "a division into alternately long and short septa cannot be recognised."[3] This separation is also shown in Kunth's figure of *L. confertum*.

According to De Koninck, *L. corniculum* bears some resemblance to the European *L. Konincki*, Ed. & H., but is distinguished by the number of its septa, size, and other characters.

Locality[4] *and Horizon.*—Dungog Road, nineteen miles from West Maitland, Parish of Barford, Co. Durham (*J. Waterhouse, M.A.*); Greenhills, near ditto (*C. Cullen*):—Mirari Limestone, Carboniferous.

Genus.—CAMPOPHYLLUM, *Edwards and Haime*, 1850.

(Mon. Brit. Foss. Corals, Introd., 1850, p. lxviii.).

Campophyllum columnare, *sp. nov.*

Pl. IX, Figs. 18–20.

Sp. Char.—Corallum of medium size, straight, cylindrical or columnar with marked accretion swellings; section circular. Septa sixty, with an equal number of secondary lamellæ; the primary septa extend inwards for about one-third the diameter of the corallum, the secondary septa for about half the length of the former; stereoplasma not materially developed; dissepiments moderately developed, forming a zone of vesicular tissue around the

[1] *Loc. cit.*, t. 2, f. 3.
[2] *Ibid.*, t. 2, f. 4.
[3] Manual of Palæontology, 3rd Edit., 1889, I, p. 295.
[4] De Koninck also cites Colocolo.

periphery, usually curved outwards, becoming wider apart on their inward extension, and passing across the interseptal loculi direct; dissepimental vesicles small and irregular in shape in the outer zone, more or less quadrangular in the more open portions of the loculi; fossula large, extending nearly half across the corallum; cardinal septum short. Tabulæ well developed, close to one another, somewhat less than half the diameter of the corallum in width, horizontal or gently rolling. Epitheca moderately thick, concentrically lined; rugæ hid by the epitheca, corresponding to the interseptal loculi.

Obs.—The genus *Campophyllum* has not hitherto been recognised in Australian Carboniferous or Permo-Carboniferous rocks, although it is known to occur both in the Devonian of New South Wales and Queensland.

The present species is a well-marked member of the genus, and possesses a copious development of tabulæ (Pl. IX, Fig. 18), which lie very closely together—in fact, are almost in contact—and usually with a gently-undulating outline. In the absence of any definite curvature of the corallum, the fossula has been assumed to be dorsal, the cardinal septum being short, and extending but a brief distance into it.

Locality and Horizon.—Binge Berry, Rouchel Brook, Hunter River, County Durham (*C. Cullen*):—Horizon doubtful, but perhaps Carboniferous.

Group—Cyathophylloidea.

Family—CYATHOPHYLLIDÆ.

Obs.—A coral referable to this family, and described by Professor De Koninck as *Cyathophyllum inversum*[1], found at Colocolo, has not come before me, but from its peculiar specific characters should be easily recognisable—indeed, these are of such a nature as almost to warrant its exclusion from the genus *Cyathophyllum*; nor have I seen his *Cyathaxonia minuta*[2] from Burragood. Two other species were also described, *Lithostrotion basaltiforme*[3] and *L. irregulare*[4], on which it is necessary to make a few remarks.

[1] Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 146, t. 5, f. 4.
[2] *Ibid*, p. 153, t. 5, f. 10.
[3] *Ibid*, p. 145, t. 5, f. 2.
[4] *Ibid*, p. 144, t. 5, f. 1.

The coral called *L. basaltiforme* does not appertain to the European species of that name; neither does it belong to the genus, nor is it Carboniferous. I have already explained[1] that Carboniferous rocks do not occur, so far as we know, on the Murrumbidgee River, the locality from which the specimen was said to have come. The coral so named by De Koninck I have collected from the blue-black Siluro-Devonian (so-called) limestone of Cave Flat, at the junction of the Murrumbidgee and Goodradigbee Rivers. It is a *Cyathophyllum*, and only on a casual examination could have been mistaken for *L. basaltiforme*.

The locality of De Koninck's *Lithostrotion irregulare*, as given in his work, is certainly a Carboniferous one; but I cannot avoid the impression that a mistake has arisen in so assigning the specimen. It is suspiciously like, in general appearance, a coral I have described[2] as *Tryplasma Lonsdalei*, from the Upper Silurian of Hatton's Corner, near Yass.

Genus—CYATHOPHYLLUM, *Goldfuss*, 1836.

(Petrefacta, I, p. 54.)

CYATHOPHYLLUM ? ZAPHRENTOIDES, *sp. nov.*

Pl. X, Figs. 4–6.

Sp. Char.—Corallum of medium size, conical, compressed towards the base; section circular. Septa forty to forty-two, with an equal number of secondary lamellæ; primary septa generally straight, here and there a little curved, proceeding direct to the centre of the calice, untwisted; secondary septa rather less than half the length of the primary; dissepiments highly developed, extending inwards for half the length of the primary septa, irregular in direction, convex outwards, oblique, or at right angles to the septa; vesicles small and irregular in shape; stereoplasma well developed forming an outer zone rather more than a third as wide as the corallum. Tabulate area very small, if present.

Obs.—The systematic position of this coral is somewhat ambiguous. The quantity of vesicular tissue would indicate *Cyathophyllum* as its genus, whilst the manner in which the septa approach the centre, and the slight evidence of tabulæ point to *Zaphrentis*.

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[1] See Foot-note, p. 6.
[2] Records Geol. Survey N. S. Wales, 1890, II, Pt. 1, p. 15, t. 1, f. 1–6.

A section taken immediately above the base of the calice shows a small central space (Pl. X, Fig. 6), to which the septa have not converged, whilst in another taken somewhat lower in the corallum they appear to be gathered together on a small tabulate area, and there is also an indefinite subdivision into groups (Pl X, Fig. 5). The development of stereoplasma about the outer ends of the septa and the peripheral dissepiments gives rise to the appearance of a well-marked zone (Pl. X, Figs. 5 and 6).

Locality and Horizon.—Binge Berry, Rouchel Brook, Hunter River, Co. Durham (*C. Cullen*):—Horizon doubtful, but probably Carbonifeous.

CYATHOPHYLLUM RETIFORME, *sp. nov.*

Pl. X, Figs. 13–15.

Sp. Char.—Corallum simple, cylindro-conical, straight, tapering very slowly; section oval or circular. Septa fifty-eight, with an equal number of secondary lamellæ, the former proceeding direct to the centre, although here and there a little curved; secondary lamellæ about half the length of the primary septa, very regular in size, length, and appearance, both more or less thickened with stereoplasma; dissepiments irregular in size and direction, forming with large and corresponding vesicles an outer zone; in an intermediate area between the thickened portions of the septa, the dissepiments are very short and small, the vesicles small and generally quadrangular, producing a more or less retiform appearance, whilst beyond the ends of the secondary lamellæ the dissepiments are less in number, distant, and direct, with oblong and narrow vesicles; stereoplasma thickening the septa but not infilling the loculi. Tabulate area small, and probably undulating or even vesicular.

Obs.—Although but an imperfect specimen the minute structure of this coral is so different from any other Australian Cyathophyloid that I feel called upon to name it as a memorandum for further investigation. There is an exterior zone of vesicular tissue in which the vesicles are moderately large and very irregular, practically forming the theca; internal to this is an intermediate area in which the secondary septa play their part. Here the vesicles are small, more or less quadrangular, bounded by direct dissepiments, producing a marked net-like appearance which is constant at various levels throughout the corallum. When seen in polished section on the specimen the regularity and frequency with which these dissepiments branch from the septa produces a spurious but somewhat crenulated appearance, reminding one at first sight of the genus *Heliophyllum* (Pl. X, Fig. 15). Cut edges of tabulæ are visible in the central area, and would seem to show that the latter were either undulating or vesicular. The great regularity of the secondary septa and dissepiments between them reminds us of *Cyathophyllum inversum*, De Koninck, but the septa in the present instance are far more numerous, and other peculiarities of the dissepiments described by De Koninck are absent.

The fossula is not distinctly visible.

Locality and Horizon.—Binge Berry, Rouchel Brook, Hunter River, Co. Durham (*C. Cullen*) :—Horizon doubtful, but probably **Carboniferous.**

Family—CLISIOPHYLLIDÆ.

Obs.—Under the name of *Axophyllum Thomsoni*[1], Prof. De Koninck described a coral from Jervis Bay and Colocolo appertaining to this family, but I regret I have not seen it.

Genus—AULOPHYLLUM, *Edwards and Haime*, 1850,[2]

(Mon. Brit. Foss. Corals, Indrod., 1850, p. lxx.)

AULOPHYLLUM DAVIDIS, *sp. nov.*

Pl. X, Figs 10–12; Pl. XI, Figs. 1–3.

Sp. Char.—Corallum very large, cylindrical, and much curved, with ill-defined irregular growth annulations. Septa fifty-eight to sixty, and an equal number of secondary lamellæ, straight, somewhat thickened, and the former equal to rather more than one-third the diameter of the corallum in length, the latter barely half the length of the primary. Peripheral area of the corallum, or interseptal space, narrow, the dissepimental vesicles rather small, closely packed, and apparently somewhat weak; intermediate area, or interlocular space, composed of irregular large concave vesicles, the secondary septa passing on to, but hardly beyond this area; interlamellar space, or

[1] Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 143, t. 3, f. 3.
[2] Emended, Duncan and Thomson, Quart. Journ. Geol. Soc., 1867, XXIII, p. 327.

central area, composed of tabulæ, usually vesicular, but sometimes complete —when incomplete the vesicles are large, low, and directed upwards—the marginal vesicles much bent downwards at their junction with those of the interlocular area, and thus assisting to form the so-called inner mural investment; when viewed horizontally this space has the appearance of a tabulate area, and the primary septa impinge somewhat on it. Fossula slightly longer than the primary septa, the cardinal septum very short, and the counter septum not specially developed. Epitheca thin; rugæ corresponding to the interseptal loculi.

Obs.—The definite tripartite division of the corallum assigns this coral at once to the Clisiophyllidæ, whilst the development of a tabulate central area, representing the pseudo-columellarian mass of other members of the family, with the inner mural investment, indicates, to my mind, the genus *Aulophyllum*, Edwards and Haime, as emended by Duncan and Thomson.

The broken concentric lines visible on the central tabulate area, at first sight, partake, to some extent at least, of the characters of the spirally-twisted plates forming the central mass of *Clisiophyllum*, *Rhodophyllum*, *Dibunophyllum*, and other members of the family; but a glance at a vertical section (Pl. XI, Fig. 3) will at once dispel this idea, and show that these lines are simply the cut or broken edges of vesicular tabulæ, the specimens having been more or less compressed laterally.

From *Aulophyllum Edwardsi*, D. & T., the type of the genus, our species is distinguished by its much greater size, less number of septa, and relatively wider areas.

A. Davidis is named in honour of Mr. T. W. Edgeworth David, B.A., of the Geological Survey.

Locality and Horizon.—Binge Berry, Rouchel Brook, Hunter River, Co. Durham (*C. Cullen*) :—Horizon doubtful, but probably **Carboniferous.** Torryburn, Logan's Station, twelve miles from Paterson, Co. Durham (*Rev. W. H. Yarrington, M.A.*) :—Horizon ditto.

Section B.—PERFORATA.

Family—FAVOSITIDÆ.

Obs.—Only two genera of Favositidæ have come under my notice—*Trachypora*, Edwards & Haime, and *Michelinia*, De Koninck. The former is by far the richest numerically, although one species of each is only known, but the latter is very rare.

The described species of *Trachypora* are Devonian, but Prof. H. A. Nicholson[1] has suggested that by the union of other hardly-separable genera "the genus will ultimately be shown to range from the Upper Silurian to the Carboniferous." *Michelinia* occurs both in the Devonian and Carboniferous.

Genus—TRACHYPORA, *Edwards and Haime*, 1851.

Trachypora, Edw. & H., Archiv. Mus. Hist. Nat. Paris, 1851, V, p. 305.
„ Nicholson, Tab. Corals Pal. Period, 1879, p. 102.

Gen. Char.—Corallum dendroid, of complex cylindrical stems, attached basally to foreign bodies, and composed of conical corallites which diverge with an increasing curvature from an imaginary axial line to open on all parts of the free surfaces. Corallites essentially polygonal, in close contact, their proper walls usually not obliterated, and in no case separated by the intervention of a true cœnenchyma. Interior of the tubes contracted by the deposition of numerous concentric layers of sclerenchyma, which increase in amount as the surface is approached. Calices superficially widely distant from one another, arranged in irregular longitudinal rows, the interspaces between them, formed by their enormously-thickened lips, being ornamented with grooves or ridges. Septa represented by radiately-placed spines or tubercles, or obsolete. Tabulæ few, remote, complete. Mural pores generally well marked, but few and irregular (*Nicholson*).

Obs.—Without entering into the relations of *Trachypora* to *Dendropora*, Michelin, and *Rhabdopora*, Ed. & H., which have been so ably handled by Prof. Nicholson, it affords me much pleasure to introduce a form from the Upper Marine Series, which appears to be a species of the first-named genus, in some of its characters bridging over the interval between it and

[1] Tab. Corals Pal. Period, 1879, p. 106.

Striatopora, Hall. These genera differ by the fact "that the thickening of the immediate periphery of the calices is carried to a much more extreme extent" in *Trachypora* than in *Striatopora*, caused by the deposition of an excessive quantity of sclerenchyma in the interior of the corallites. This results in the formation of a much larger extent of free surface exteriorly between the calices, which is ornamented with grooves and ridges. Such is the structure of the species about to be described, but it undoubtedly also approaches *Striatopora* in the somewhat erect, sub-angular, and polygonal mouths of the calices, and the highly-developed septal striæ.

A microscopic examination of this species—which it is proposed to call *T. Wilkinsoni*, in honour of the Government Geologist—enables me to quite support Prof. Nicholson's statement[1] that there is no proper cœnenchyma nor a columella in *Trachypora*. Lastly, it has been proposed to unite the Carboniferous genus *Rhabdopora* with the present, a union which will receive some support from the geological position of *T. Wilkinsoni*.

TRACHYPORA WILKINSONI, *sp. nov.*

Pl. I; Pl. VI, Figs. 1 and 2.

Sp. Char.—Corallum of stout cylindrical bifurcating stems, from four to six lines in diameter, but increasing to nine lines immediately previous to bifurcation, sometimes giving off additional blunt abortive branches, with the entire free surface, like that of the parent stems, occupied by calices, and presenting a roughened hackly appearance from their exsert mouths. The latter are round or oval, of variable size, the larger about three-fourths of a line in diameter, irregularly placed as to size, arranged roughly in longitudinal rows, and their mouths set a little obliquely to the longer axes of the corallites, but the lower edge of each calice slightly exsert. Intercalicular surface extensive, ornamented with irregular vermicular ridges and tubercles, the former sometimes assuming a roughly radiate appearance. Septa represented by very conspicuous radiating ridges within the calice mouths, separated by intervening deep grooves. Tabulæ irregularly placed, sometimes remote, at other times contiguous, both horizontal and oblique. Mural pores small and irregularly distributed.

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[1] Tab. Corals Pal. Period, 1879, p. 104.

Obs.—When the surface of the corallum becomes at all worn the slight obliquity of the calice mouths is entirely lost, and the septa are then visible round the otherwise rather funnel-shaped calices. They vary from eight to ten, and the intermediate depressed spaces, or grooves, are even more conspicuous than the septa themselves.

Both in longitudinal and transverse sections, the enormous thickening of the walls towards the peripheral portion is very apparent, and in some cases the calices become almost obliterated by it, although the primordial walls are usually still to be seen, and the original polygonal outline of the corallites. This thickening increases towards the periphery of the corallum. The great length of the corallites is also noticeable in vertical sections, and the fact that they remain open throughout their whole course, the outward curvature from the central or axial portion of the corallum being a gentle one. The corallites are in close contact with one another, but even at an early point in their course the same thickening of the walls is visible, although to a less extent than towards the peripheral portion. The complete tabulæ are placed at variable distances apart, sometimes horizontal, at other times oblique to the axial line of the corallites they traverse.

When well preserved the margins of the calices are erect and thickened; this, with their deep funnel-shaped interiors and strong septa at once recalls the structure of *Striatopora*, Hall.

The pores are very irregularly distributed. In some cases they occur singly, at other times are clustered together. They are quite round, and, for the size of the corallite, large. Some very instructive internal casts of the calices of this coral have been found at Boorook, (Pl. I, Fig. 8) in which not only the grooves left by the imprint of the septal striæ are visible, but projecting from these casts, either at right angles or at a slightly-inclined angle, are a number of thorn-like projections, which are the infillings of the pores placing the various corallites in communication with one another. The whole of the immensely-thickened walls have been removed, but the ornamentation of the surface is preserved on the impression of the fossil. The distance apart of these "thorns" excellently demonstrated the thickness attained by the secondary deposit. It is quite clear that not only the peripheral portions were thickened, but the central vertical portions of the tubes likewise, whilst the proper wall is very apparent. There can be no possibility of doubt that the septal ridges extended for some distance into the calicular orifices, as shown by the grooves on their internal casts.

A peculiar instance of contrariety of growth is shown in Pl. I, Fig. 3, where the calices at either end of the specimen have grown in opposite directions opening towards one another.

Trachypora Wilkinsoni is, with *Stenopora crinita*, one of our most characteristic[1] corals of the Upper Marine Group.

Locality and Horizon.—Mulbring (Mount Vincent), near West Maitland, Co. Northumberland (*Messrs. T. W. E. David, B.A., C. Cullen, —Twine, and S. Dodds*); Barren Flat, Shoalhaven District, Co. St. Vincent (*H. Moss*); Shoalhaven, Co. St. Vincent (*C. Cullen*):—**Upper Marine Series.** Boorook,[2] Co. Buller (*D. A. Porter*):—? **Upper Marine Series.**

Genus—MICHELINIA, *De Koninck*, 1842.

(Descrip. Anim. Foss. Terr. Carb. Belgique, Fas. 1, p. 29.)

MICHELINIA, *sp.*

Plate IV, Fig. 1.

(Comp. *Michelinia tenuisepta* (Phill.), Edwards and Haime, Mon. Brit. Foss. Corals, 1852, Pt. 3, p. 155, t. 44, f. 1, 1 *a-b*.

Obs.—A portion of a small specimen represents the only example of this genus which has come under my notice from Australian Permo-Carboniferous rocks. The specimen has been broken across, and, although somewhat obliquely, the character of the corallites is well displayed. The epitheca is not well preserved, nor are there remaining any radiciform processes, even if the species possessed them, which I think doubtful. The calices are from seven to nine millimetres wide, but as the surface has been fractured obliquely, the actual diameter would be less. The tabulæ, from their peculiar arrangement, give rise to the characteristic vesicular tissue, the vesicles being small and very numerous, but there are no septa visible. The walls of the corallites are moderately thick, and freely pierced by numerous irregularly-placed pores, giving to them under the hand-lens a slightly cribriform appearance. Vertical spinules on the tabulæ are not visible.

[1] The original specimens used by me were limited in number, and poor in outward preservation, compared with a very fine and large collection since made at Mulbring by Mr. Cullen. Many of these exceed the measurements given above, but the largest fragment which has come under notice is a specimen three inches long, with a diameter of one and a quarter inches, presented by Mr. Twine.

[2] The ultimate geology of this district appears to be but little known. In the late Mr. Lamont Young's "Report on the Boorook Silver Mines" (Ann. Report Dept. Mines N. S. Wales for 1878 [1879], p. 35) the silver lodes are said to be associated with shales of Upper Devonian age. The fossils, however, which have come under my notice so far from this locality do not differ from those of the Permo-Carboniferous areas.

The presence of so little of the corallum renders specific identification difficult—indeed, almost impossible—but it may be pointed out that the absence of radiciform processes, and the general appearance of the vesicles, would indicate *Michelinia tenuisepta*, Phillips[1], as its nearest ally.

Locality and Horizon.—Carrol, near Somerton, Co. Buckland (*D. A. Porter*[2]) :—Horizon doubtful, but probably Upper Marine Series.

Family—SYRINGOPORIDÆ.

Obs.—The second family of the Perforata, of which we have any record, is the Syringoporidæ, but unfortunately the Collection does not at present contain examples. The late Prof. De Koninck described two species—*Syringopora reticulata*, Goldfuss[3], from the Upper Marine Group of Muree, near Raymond Terrace, Hunter District; and *S. ramulosa*, Goldfuss[4], from the Lower Carboniferous rocks of Burragood, Paterson River. Both specimens formed a portion of the Rev. W. B. Clarke's Collection, and were destroyed in the Garden Palace fire. The figure of the first-named has very much the appearance of an irregularly-grown, openly fenestrate *Fenestella* seen from the reverse side. That of the second species closely resembles the impression of some of our *Protoreteporæ*.

Family AULOPORIDÆ.

Genus—CLADOCHONUS, *M'Coy*, 1847.

Jania (pars), M'Coy, Synop. Carb. Lime. Foss. Ireland, 1844, p. 197. (Non Lamx).
Cladochonus, M'Coy, Ann. Mag. Nat. Hist., 1847, XX, p. 227.
Pyrgia, Edwards and Haime, Archiv. Mus. Hist. Nat. Paris, 1851, V, p. 310.
Cladochonus, De Koninck, Nouv. Rech. Anim. Foss. Terr. Carb., Belg., 1872, Pt. 1, p. 150.
" Nicholson and Etheridge, jun., Geol. Mag., 1879, VI, p. 289.
" Nicholson, Tab. Corals Pal. Period, 1879, p. 222.

Gen. Char.—Corallum in the form of an erect branching colony, fixed at the base, by one or more isolated points of attachment; composed of thick conical corallites, suddenly dilating at regular distances into cup-shaped terminal calices, either singly or in groups, when singly usually bent from

[1] *Calamopora*, Geol. Yorkshire, 1836, Pt. 2, p. 201, t. 2, f. 30.
[2] A second specimen has lately been presented by Mr. Porter, somewhat larger and better preserved than the above. In this the tabulæ are highly vesicular and convex.
[3] Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 155, t. 7, f. 3.
[4] *Loc. cit.*, p. 156, t. 7, f. 4.

one another alternately in opposite directions, successive corallites taking their rise from the base of the preceding calice. Tabulæ sometimes present, at others absent, the visceral chambers connecting freely by their bases; when present, remote, delicate, and complete. Septa representedby delicate striæ. Epitheca strong. Increase takes place by lateral budding.

Obs.—"These singular and beautiful corals," says Prof. M'Coy,[1] "have some relation to *Aulopora*, but differ in their curious erect habit, regular, angular mode of branching, slender, equal, stem-like tubes and abruptly-dilated terminal cups bent in nearly opposite directions. The *Aulopores* are attached for the most part by one side; the tubes *gradually* expand to the mouths, which all open nearly in one direction; they have no regular distance for branching, and frequently anastomose. The present corals have also much thicker walls to the tubes, the central hollow being proportionally very small."

According to Prof. L. G. De Koninck,[2] the tubes of the European *Cladochonus Michelini* communicate freely with one another. I have only examined a limited series of *C. tenuicollis*, but they are certainly similar in structure. Other specimens, however, from the Carboniferous Limestone of Scotland, described by Prof. Nicholson and the Writer, and believed to be *C. Michelini*, were found to possess remote, delicate, and complete tabulæ, either straight or slightly curved. The relation of this genus to *Aulopora* has been summed up by Prof. Nicholson[3] in the following words—"There is nothing in the internal structure of *Cladochonus*, M'Coy (= *Pyrgia*, Edw. & H.), which would separate it from *Aulopora*, Goldf., and the generic distinctness of the two can only rest upon the feature that the corallum of the former is erect, whereas in the latter it is creeping and parasitic."

Cladochonus tenuicollis, *M'Coy*.

C. tenuicollis, M'Coy, Ann. Mag. Nat. Hist., 1847, XX, p. 227, t. 11, f. 8.
" De Koninck, Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 154, t. 7, f. 2.
" Etheridge, Junr., Cat. Australian Foss., 1878, p. 34.

Sp. Char.—Corallum branching in the form of an irregular zigzag, but more or less in the same plane. Calices large, obliquely-oval, cup-shaped, and terminal, united towards their bases by slender pipe or pedicle-like corallites, composed of a thick homogeneous tissue, the internal connecting passage

[1] Ann. Mag. Nat. Hist., 1847, XX, p. 227.
[2] Nouv. Rech. Anim. Foss. Terr. Carb. Belg., 1872, Pt. 1, p. 153.
[3] Tab. Corals Pal. Period, 1879, p. 223.

remaining very narrow; the calices are usually single, alternately springing from the stolon-like corallites right and left, occasionally, however, two issue from the same corallite, more or less opposite one another. Tabulæ absent. Septa, as very fine and numerous striæ, extending the whole depth of the calices.

Obs.—Prof. De Koninck has very aptly expressed the form of this peculiar coral by comparing the separated corallites to an ordinary clay-pipe. As a rule, the calices spring from the stolon-like corallites singly, but at times two appear to issue from the same pedicle.

The tissue composing the corallites is very dense, and apparently fibrous, the connecting passages very narrow, and no evidence of tabulæ has been observed. With the exception of a very small portion of surface of one of the calices, the tissue appears to be perfectly homogeneous, but at this point a vermicular structure is apparent. I regret that the material at my disposal is too limited in quantity to warrant the preparation of microscopic slides, and I am, in consequence, unable to institute a comparison with the structure of the genus *Monilopora*, N. & E.[1] Should further research establish the presence of a reticulate structure in the Australian coral it will necessitate a re-examination of *Monilopora*.

Locality[2] *and Horizon.*—Three-quarters of a mile north-west of Pallal Station, Horton River, Co. Murchison (*C. Cullen*) :—horizon doubtful, but probably Carboniferous. Dungog Road, nineteen miles from West Maitland, Co. Durham, (*Messrs. J. Waterhouse, M.A.; T. W. E. David, B.A.*, and *R. Etheridge, Junr.;* and *C. Cullen.*) :—Mirari Limestone, Carboniferous.

Order ?—MONTICULIPORIDEA.[3]

Family—MONTICULIPORIDÆ.

Sub-Family—Stenoporinæ.[4]

Obs.—The family Monticuliporidæ has been subdivided by Messrs. Waagen and Wentzel into three sub-families, of which the Stenoporinæ forms the third, and is certainly a most convenient section. They place in it two genera—*Stenopora*, Lonsdale, and *Geinitzella*, W. & W. To these I would add *Tabulipora*, Young, for reasons to be explained later.

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[1] Geol. Mag., 1879, VI, p. 293.

[2] The following localities had been previously given—Dunvegan by Prof. M'Coy (Ann. Mag. Nat. Hist., 1847, XX, p. 227), and Burragood by Prof. De Koninck (Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 154).

[3] "Zoological affinities uncertain," Nicholson, Manual of Palæontology, 3rd Edit., 1889, I, p. 89.

[4] Waagen & Wentzel, Pal. Indica. Salt Range Fossils, 1886, Vol. I, Part 6, p. 875.

The following brief scheme explains their respective positions :—

Walls with periodical moniliform swellings more or less developed	Moniliform swellings rudimentary	Tabulæ complete	*Geinitzella.*
	Moniliform swellings well developed		*Stenopora.*
		Tabulæ incomplete	*Tabulipora.*

Genus—STENOPORA, *Lonsdale*, 1844.

Stenopora, Lonsdale, in Darwin's Geol. Obs. Volc. Islands, 1844, p. 161 (*note*)

„ Lonsdale, in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 262.

Tubuliclidia, Lonsdale, Bull. Soc. Géol. France, 1844, I, p. 497.

„ Lonsdale, in Murchison's Geol. Russia, &c. 1845, I, pp., 221 & 631 (*note*).

Stenopora, Nicholson & Etheridge, Junr., Ann. Mag. Nat. Hist., 1879, IV, p. 265.

„ Nicholson, Tab. Corals Pal. Period, 1879, p. 168.

„ Waagen & Wentzel, Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, p. 885.

(Compare *Geinitzella*, Waagen & Wentzel, *loc. cit.*, p. 880.)

Gen. Char.—Corallum ramose (aborescent) or sublobate, sometimes massive, occasionally frondescent, attached to foreign bodies, usually by the centre of its base, and composed of tubular corallites, which are nearly vertical in the centre of the corallum, and radiate outwards from an imaginary axis at various angles to open on all points of the free surface. Corallites polygonal, thin-walled, and more or less completely in contact ; in the outer, curved, or peripheral portion of their course more or less cylindrical, and annulated by periodical ring-shaped thickenings, which are sometimes placed at corresponding levels in contiguous tubes. Visceral chambers in the outer portions of the tubes alternately contracted and dilated in correspondence with the periodic thickening of the walls just spoken of, but open and subpolygonal in the axial portion of the corallum. Acanthopores usually present.

Septa obsolete. Tabulæ remote, usually placed at corresponding levels in contiguous tubes, but at irregular distances within the same tube, generally complete, but sometimes perforate, especially at the final period of growth of the corallites, when the calices at times appear with their terminations closed by a perforated lid. Mural pores absent. The massive forms usually have the corallites constricted at intervals on the same level, representing periodic stages of growth, and giving to the entire mass a stratified appearance. Gemmation intermural.

Obs.—The corallum in *Stenopora* is usually more or less branched, but the branches may be so thick, or may so extensively coalesce, that its general form becomes that of a lobate mass. The corallites radiate in all directions from an imaginary axis, and present very different appearances in the central and circumferential portions of the corallum respectively. In the central or axial portion the tubes are nearly vertical, essentially polygonal or prismatic in shape, have thin walls, and are nearly or quite in contact with one another throughout. As they pass upwards the tubes gradually diverge, coming at last to be nearly horizontal, and preserving this direction for a considerable distance, till they at last open upon the surface. There is thus an exterior zone of the corallum, in which the corallites are nearly transverse to the axis of the branches, and in this region they have a generally cylindrical appearance. We are too little acquainted with the perfect corallum in the majority of species to speak definitely as to its ultimate outline in each one. *Stenopora ovata*, *S. Leichhardti*, *S. australis*, and *S. tasmaniensis* are all ramose species so far as we know them, but I have reason to suspect that the first three, in this condition, are but the terminal and younger portions of much more massive coralla, perhaps arising from coalesced branches, but hardly, I think, from definitely-grown lobate masses like *S. crinita*. It will be shown further on that even this species does at times shoot forth from its otherwise undulating and semi-mammillated surface out-growths of a ramose character. I have been favoured by Mr. R. M. Johnston, F.L.S., of Hobart, with a Tasmanian foliated *Stenopora*, the corallum growing in rather undulating tabular or foliated expansions, like that of *Chætetes hyperboreus*, N. & E.,[1] the corallites opening on the free lateral surfaces, and arising from a median line, and imaginary axis.[2]

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[1] Nicholson & Etheridge, Junr., Proc. Linn. Soc. (Zool.), 1878, XIII, p. 367.

[2] Two such forms of growth have already been mentioned by Prof. H. A. Nicholson and the Writer, both from Tasmania, and now in the British Museum. The microscopic structure of one was compared to that of *S. ovata*; the other, "a remarkable frondescent specimen," was compared to *S. tasmaniensis*.

Specimens fractured longitudinally usually exhibit the corallum subdivided in a similar direction into a number of superimposed strata of greater or less thickness. No better example of this can be adduced than in Lonsdale's old figure of *Stenopora ovata*, and it is equally well shown in our Pl. II, Figs. 1 and 2, Pl. III, Figs. 2 and 3, and Pl. IV, Fig. 2. These strata, or corallite internodes, it is believed, indicate periods of growth, a cessation of active increase taking place at the upper line of each stratum, and not merely lines of high tabular development, as in some corals. They are usually well marked in most of the species, but probably more apparent in *S. crinita* (Pl. II, Figs. 1 and 2), and *S. ovata*; and least so in *S. tasmaniensis*.

Fractured surfaces of *S. Leichhardti* present even a plumose appearance, arising from a slight tendency of the branches to expand at their apices. The same feature is to some extent noticeable in another species from the chloritic rock of the Gympie Gold-field.

The general features of the surface in the Australian *Stenoporæ* are moderately uniform, but in *S. crinita*, as will be explained later, monticules have been noticed (Pl. V, Fig. 1). At the same time, other important modifications may become apparent when we become better acquainted with the exterior of the corallums of some of the other species.

We know equally little regarding the method of attachment of the corallum in *Stenopora*. In our earlier description of the genus, Prof. Nicholson and the Writer used the term "rooted below," and although it is still quite possible that some of the species may have been so fixed to submarine bodies, we now have definite evidence that at least one species, *S. crinita*, was firmly attached (Pl. III, Figs. 1 and 2) by its general base to other objects, and in fact enveloped them. The undescribed Tasmanian species cannot be said to be encrusting, as the foliations are bilaminar, and it is therefore within the range of possibility that this may have been a rooted form. Taking a typical *Stenopora*, thin sections of the corallum show different appearances in different portions. Thus, in a transverse section across a branch, the axial corallites are seen to differ in no essential features of their structure from those of *Monticulipora* or *Favosites*, except, of course, that there is no trace of the septal spines of the latter. Each possesses its own wall, which is not abnormally thickened, the boundary between contiguous tubes being clearly indicated, generally by a distinct dark line. The tubes in this portion of the corallum are also regularly polygonal (triangular, hexagonal, heptagonal, and pentagonal), and variable in size, and are certainly, as a rule, in close contact. On the other hand, in sections tangential to the branch, and taken a little below the surface, the tubes are cut across on their outer portions, where they are periodically thickened. The tubes still appear to be polygonal and in contact, each being bounded externally by a well-marked dark line; but the appearances presented by the area within this boundary-line apparently vary according as the section traverses the tubes at the level of their thickened portions, or at that of the unthickened intervals between the latter. In the former case the visceral chamber is seen to be greatly contracted, and may even be reduced to a comparatively small rounded or sub-polygonal central tube, which is, in turn, surrounded by a thickened ring of sclerenchyma, which usually shows distinct traces of its being composed of successively-deposited concentric laminæ. In the latter case there is still a ring of sclerenchyma within the dark outer polygonal boundary; but this ring is of small thickness comparatively, and the central tube is wide and open. The walls are thickened at short intervals by annular accretions of growth, the portions of the tubes between them retaining their normal diameter. These thickened portions are usually placed at corresponding levels in all the corallites.

In many parts of tangential sections the corallites exhibit few features that would satisfactorily separate them from similar sections of certain Monticuliporidæ, though they usually have exceptionally thick walls, and often exhibit a dark ring a little within the true wall, and concentric with the latter.

Longitudinal sections of the corallites show the periodical annular thickenings of the tubes in a very instructive manner, and demonstrate that these are really thickenings of the wall, projecting both externally and internally—in fact, the longitudinal section of the wall has a regularly moniliform appearance, owing to its successively traversing thickened and un-thickened segments. Sections of this kind also show that there exist remote and usually complete tabulæ, which are generally placed at approximately corresponding levels in all the corallites of a single colony.

Such being a general view of the corallum of *Stenopora*, we may now consider some points of its structure in detail. The secondary deposit which forms so conspicuous a feature in the tubes of most New South Wales and

Queensland *Stenoporæ* presents some interesting points of study. It is composed of concentric zones of successively-deposited matter, and, when present, regularly follows the outline of the corallite, which it assists in filling up. This is seen to greatest advantage in *S. crinita*, and from the varying colours of the laminæ is best compared to the concentric structure of a nodule of clay ironstone, which it much resembles.

In *S. crinita*, *S. ovata*, and *S. tasmaniensis* it completely follows the outline of the tubes, but it is always much less marked in the last-named species. In the two first-named the corallite wall is generally succeeded by a zone of clear calcite, this by a ring of dark ferruginous deposit of greater or less thickness, at times a mere ring, at others broadening into a zone; this again by another layer of clear calcite, which may or may not completely fill the visceral chamber. In the latter case its inner or free margin is ragged, the centre being occupied by matrix, or a subsequent infiltration of carbonate of lime (Pl. VI, Figs. 3 and 4). There are even degrees and variations in this structure, for it sometimes happens that beyond the first dark ring the whole chamber is filled with clear calcite, or this ring may expand into a broad zone completely infilling the tube. In some few examples of *S. ovata* the outline of the tubes is followed immediately by a pale-coloured ring of sclerenchyma, of radiately fibrous structure. In vertical sections of *S. crinita* the moniliform walls are invested in a somewhat similar manner.

In *S. australis* a modification of this secondary investment is seen. It is never in contact with the polygonal wall for more than half or two-thirds of its circumference, being separated from the remaining part of the tube by a distinct and conspicuous interspace, which is filled in the fossil with transparent calcite. Not only is this partial interspace between the inner ring and the outer wall apparently always present, but it seems to be always situated upon the same side of all the corallites in any particular section.[1]

It has already been mentioned that *S. tasmaniensis* exhibits this filling of the tubes to a far less extent than the other species mentioned; and it is a peculiar fact that in all the Tasmanian species examined by me[2] the deposit is absent, but in the Indian forms of *S. ovata* it is to some extent developed.[3] In the case of *Stenopora australis* the peculiar appearance there

[1] Nicholson & Etheridge, Junr., Ann. Mag. Nat. Hist., 1879, IV, p. 272; *Ibid*, 1886, XVII, t. 3, f. 5.

[2] With the exception of *Stenopora informis*.

[3] Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, t. 110, f. 1c.

present was accounted for by Prof. H. A. Nicholson and the Writer[1] on the supposition that the tabulæ, in the first place, were perforate, and in the second, incomplete. The facts, however, detailed above, and those to be given later under the heading "tabulæ," do not appear to bear out this opinion, which, I think, must be abandoned. I can, after a further and more extensive acquaintance with *Stenopora*, only arrive at the conclusion that this peculiar investment, in spite of its extraordinary development, is principally of inorganic origin, and is produced by a post-mortem deposition within the cavities of the tubes, as indicated by its presence in some examples and not in others.[2]

The proper wall in its unthickened state is exceedingly uniform in appearance and thickness, and is usually visible as a dark line, so thin and structureless as to render any subdivision between contiguous corallites perfectly imperceptible, and thus resembling such Monticuliporoids as *Monticulipora (Diplotrypa) petropolitana*, Pander, sp.[3] This appearance is particularly characteristic of Tasmanian specimens, but in no Australian example have I met with that peculiar disintegration into dots, resembling a string of beads, figured by Waagen and Wentzel in the walls of the Indian variety of *S. ovata*.[4] Nor has the slightest indication presented itself of such wall-structure as characterises *Monticulipora (Heterotrypa) ramosa*, D'Orb.,[5] wherein each visceral chamber is enclosed by a dark line or marginal ring, usually circular or oval in outline, marking the original boundary of the tube, and the interspaces between these dark lines filled in by sclerenchyma of a different texture and much lighter colour.

It has been supposed by Prof. H. A. Nicholson that in the Monticuliporidæ each tube or corallite theoretically possesses a perfectly independent and complete wall,[6] that is, of two thin laminæ adpressed, each appertaining to a separate corallite. Theoretically, no doubt, this view of the Monticuliporoid wall-structure is strictly accurate, but in *Stenopora* I have quite failed to detect, by direct microscopic examination, except in *S. crinita*, any bilaminar structure in its walls, as also did Messrs. Waagen & Wentzel.[7]

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[1] Ann. Mag. Nat. Hist., 1886, XVII, p. 176.

[2] As a further proof of this, I may mention that a specimen of *S. crinita* has recently come before me from the Wollongong District, in which the corallites are almost completely destitute of secondary deposit. This is of great importance, from the fact that Wollongong is amongst the localities which have yielded the best specimens showing the secondary deposit.

[3] Nicholson, Genus Monticulipora, &c., 1881, p. 37, f. 1A.

[4] Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, t. 110, f. 1c.

[5] Nicholson, *loc. cit.*, p. 39, p. 37, f. 1B.

[6] Nicholson, *loc. cit.*, p. 36.

[7] Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, p. 863.

If, therefore, we dismiss such an arrangement of these important structures, how is it that on longitudinal fracture the exterior of the various corallites has usually been supposed to be on view. According to the authors just referred to, such is not the case, and they have advanced the following ingenious explanation to account for it. Speaking of the peripheral region of a Monticuliporoid coral, they say that longitudinal severance always takes place along the primordial wall, the latter adhering to one side of the fracture, the secondary thickening retaining its connection with the other side of the break. In the axial zone fracture takes place in the same manner, but there being little or no secondary thickening the other side of the break exposes "the smooth internal cast of the adjoining individual."[1] Appearances presented by our *Stenoporæ* seem to me explicable only on this supposition. The wall in freshly-fractured specimens appears as a thin pellicle-like substance of light colour, and peels off as such. In *S. crinita* this peculiarity is so marked that when combined with the stratified condition of the corallum the corallites of a given growth-stage break off as individual disjointed hexagons, octagons, or polygons, as the case may be. The presence of intermural gemmation in *Stenopora*, almost exclusively, would lead us, to some extent, to expect the exposure of the exterior of the corallites on fracture, and not, as in *Chætetes*, in which fissiparity exists, the interior. From these combined causes, therefore, it is very difficult to account for the appearance of the interior as in *Stenopora*, unless it be by the above hypothesis. A condition of preservation which would appear to go far to bear out this view occurs in *S. crinita*, in which the longitudinal surfaces of what Waagen and Wentzel would call the internal casts of the tubes are invariably marked by the impressions of downwardly-directed crescentic imbrications of microscopic size. These, I believe, are the impressions of the superimposed conical layers of sclerenchyma composing the moniliform annulations of the walls, left after fracture, as explained by the authors above quoted.

The structure of thickened portions of the walls is identical, whether the section be taken from the axial region, as in *S. crinita*, or the peripheral zone of another form, and the polygonal outline becomes lost. The transition from the dark, hair-like proper wall (Pl. VII, Figs. 2 and 3) to the mass of sclerenchyma forming the thickened wall is always abrupt, but the moment this has taken place the structure becomes well exemplified, the sclerenchyma or concentric fibro-laminar deposit, probably representing the obliquely-cut edges of the superimposed layers of which the thickened annulations are

[1] *Ibid.*, p. 864.

composed. The laminæ, when visible, are invariably concentric to each corallite wall, but often do not extend to the centre of the interstice, in which case a more or less undefined narrow central space is left, common to the two adjoining tubes (Pl. VII, Fig. 4). This is either apparently structureless and homogeneous, and free of the concentric lines, or is occupied by the primordial wall, which, in these cases, remains in the thickened wall of sclerenchyma as a simple dark line (Pl. VII, Fig. 3). The median space, when structureless, may be, generally speaking, narrow and contracted, or, as in certain Tasmanian species, the frondescent condition of *S. ovata* for example, very wide. As regards the superficial area of these structures there does not appear to be any fixed rule. One or the other may occupy the whole microscopic field, or there may be only very limited portions of it so taken up.

In longitudinal sections, whether of the axial or peripheral region, the structure, as apart from the arrangement of the periodical moniliform thickenings, is identical, and strictly follows the general plan of other Monticuliporoids, as described by Prof. H. A. Nicholson[1] in peripheral sections, being a "succession of superimposed conical layers of sclerenchyma, which are deposited one above the other as the growing margin of the wall is carried upwards." Different appearances are produced according to the position in which a corallite is sectioned. If the section runs truly across the centre of the corallite we simply have presented to us the thickened lateral peripheries of the tube[2] (Pl. VI, Figs. 7 and 8; Pl. VII, Figs. 1 and 9); but if the section is taken contiguous to either the fore or aft wall we then see, in addition, a deposit of sclerenchyma also of a fibro-laminar structure[3] (Pl. VII, Fig. 5), thrown into a series of folds, concave downwards, and thus differing from the "superimposed layers" described by Prof. Nicholson. These diverse appearances are common in all good sections, and may be studied in the figures referred to below. In one singular section (Pl. VII, Fig. 6) the fusiform thickenings are hollow, with only the bounding walls preserved.

The chief modifications observed in the periodical thickenings of Australian species are the following:—In the axial region of *S. crinita* (Pl. VI, Fig. 6), this being the only form in which axial swellings are developed with anything like frequency, the latter are elliptical or fusiform in outline,

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[1] Genus Monticulipora, &c., 1881, p. 41.
[2] Ann. Mag. Nat. Hist., 1886, XVII, t. 3, f. 4 & 8; Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, t. 110, f. 1*d*.
[3] Ann. Mag. Nat. Hist. 1886, XVII, t. 3, f. 10; Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, t. 110, f. 3 *d* & *e*.

small, often single, and at the same level over a considerable extent of the corallum, and having the appearance, under a low power, of strings of widely-separated semi-transparent beads. At times the wall, above or below, usually above, is to some extent thickened, and it may happen that at times several swellings follow one another rapidly, but without becoming confluent. In *S. tasmaniensis* and *S. ovata*, when moniliform swellings do occur in their axial regions, they are much on the same plan as the above. On examining the peripheral region of the several species we find a much greater diversity of structure existing. In *S. ovata* the annulations of the tubes, on the latter passing from the axial to the peripheral zone, gradually lose their elliptical form and become oval-pyriform, approaching nearer to one another as the surface of the corallum is approached. Although becoming ultimately close set and forming a continuous line, with great regularity, like a series of waves, the swellings never thoroughly lose their pyriform outline, and, in consequence, do not become confluent. The moniliform swellings of *S. australis*, N. & E.,[1] are similar, but those of the axial region of this species and *S. Leichhardti* I am not acquainted with. Near the surface of the corallum many of the swellings in *S. ovata* are quite cæpiform (Pl. VI, Fig. 8), and appear to have their larger ends reversed. In *S. Leichhardti*, N. & E.,[2] the swellings have quite lost the moniliform or annular outline, and have become perfectly confluent, except just at the periphery of the corallum, where the characteristic form may still be recognised. The aspect usually presented in sections of this species is that of a series of thickened walls, gradually increasing in width upwards, with uniform margins, or at any rate only widely serpentine. In *S. tasmaniensis* the moniliform swellings are, when single, generally elliptical, but sometimes cæpiform, but, as a rule, the whole peripheral line in this species becomes thickened into a dense mass of sclerenchyma (Pl. VII, Fig. 9), but in which the laminar structure is still visible. Lastly, in *S. crinita* the moniliform swellings appear, at the termination of growth periods, to retain the same general character as in the axial region, simply becoming closer together, but still possessing the same fusiform appearance. One very characteristic feature, however, in these bodies is their much more slender outline than in any of the others.

The interstitial surface of the corallum and the angles between the corallites are more frequently than not occupied by small blunt spines which project more or less above the general surface. These have been termed by

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[1] Ann. Mag. Nat. Hist., 1886, XVII, t. 3, f. 6.
[2] Ann. Mag. Nat. Hist., 1886, XVII, t. 3, f. 8.

Prof. Nicholson[1] "spiniform corallites," and by Messrs. Nicholson and Foord[2] "acanthopores. They are, apparently, the "wandröhrchen" of Dybowski[3], and the "newly-developed gems" of Messrs. Waagen and Wentzel[4]. I have only had an opportunity of macroscopically examining two Australian species, *S. tasmaniensis* and *S. ovata*. The characters of the surface in the first will be found under its specific description, but in *S. ovata* the acanthopores do not appear to have that marked spiniform appearance so noticeable in the former species. This, however, may perhaps be due to imperfect preservation.

In sections of the characteristic New South Wales species, *S. crinita*, acanthopores are of variable occurrence. They appear in some specimens at all the angles between the corallites, but in other cases whole sections may be examined without a single acanthopore being present, notwithstanding that the walls of the corallites are thickened. In *S. ovata* the acanthopores are of large size, almost always at the angles, and very frequently on the interstitial surface. In *S. australis*, acanthopores have not, so far, been observed; but in *S. Leichhardti* they are irregularly scattered, as in *S. ovata*. On the other hand, in *S. tasmaniensis* these bodies form one of the most characteristic surface features of the species.

In a longitudinal section, say of *S. ovata*, the acanthopores appear as fibrous strings in the walls of the corallites, and usually possess a similar fibrous structure when thickening has taken place. In some cases, although not often, the acanthopore tubes appear hollow, filled with clear calcite, and the walls strong and determinate, but these need not in any way be confounded with young corallites. It is, however, in horizontal sections, whether tangential or axial, that the structure of these bodies can be best interpreted. In sections of an entire branch, wherein both the vertical, peripheral, and axial horizontal can be studied, the acanthopores are usually visible in the latter, at the angles of the corallites, as dark bead-like spots, probably representing, as suggested by Messrs. Waagen and Wentzel, their initial stage. It is then easy to trace the relation of these bodies to the fibrous strings, or hollow tubes, as the case may be, visible in the former portion of the sections.

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1 Genus Monticulipora, &c., 1881, p. 45.

2 Ann. Mag. Nat. Hist., 1885, XVI, p. 497 (*note*).

3 Die Chaetetiden der Ostbaltischen Silur-Formation, 1878, p. 9.

4 Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, p. 871.

When acanthopores are present in unthickened corallite walls their position is usually at the angles between the corallites, but I have before me some remarkable instances both of New South Wales and Tasmanian specimens in which they are plentifully distributed along the course of the proper wall, without the latter showing the slightest trace of deposited sclerenchyma. In this position the acanthopores are separated by intervals of the wall, or are sufficiently close for their peripheries to be in contact. When in what may be termed their normal position, that is, at the angles of the corallites, the acanthopores may appear either as dark spots, in the initial stage, or as round masses of semi-transparent, fibro-concentric sclerenchyma. Those met with on the unthickened proper wall are also in this state, and sometimes, in addition, as hollow bodies occupied by a clear sparry infilling. On some highly-thickened walls the acanthopores are indicated as irregularly-distributed small openings without distinctive features, such as now lie before me in a Tasmanian *S. ovata*, and the Queensland *S. Leichhardti*. In a very instructive tangential section (Pl. VII, Fig. 8) of the last-named species, taken slightly obliquely to the surface, the acanthopores appear as definite tubes, with determinate walls passing through the substance of the thickened corallite walls.

The acanthopores, when more fully developed, are formed by similar fibro-laminar sclerenchyma to the thickened corallite walls, deposited concentrically. They appear either as depressions with a perspective concavity, or papillar eminences with a dark central spot. At times the thickened rod-like mass seems to occupy the centre of an ill-defined triangular space (same as visible in Pl. VII, Fig. 3) in the angles of the corallites, but separated from edge of the former by a minute infilling of matrix. The structure within the perspective concavity even differs, and may consist of a ring of matrix, or even secondary deposit, followed by a mass of sclerenchyma, with a dark central nucleus, or a vacuity filled with clear calcite. Another modification observed consists in the perspective cavity filled with a clear sclerenchymous deposit, itself bearing a dark spot, central or excentric. In the latter case the clear ring is not continuous all round, but, like the secondary deposit in the corallites of *S. australis*, is deficient at some part of its course. A similar instance has been figured by Messrs. Waagen and Wentzel in their *Geinitzella crassa*, Lonsd., sp.[1] A few instances have presented themselves in which the acanthopores are situated quite on the margin of an interstice, and when

[1] Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, t. 114, f. 1c.

in this position appear small, and more or less aborted. The margins of contiguous corallites, both in the unthickened and thickened condition, are often rendered uneven by the projection of the acanthopores inwards. In the first case they give to the wall a moniliform appearance, and in the second they render the inner outline of the corallite irregular, or fluctuating, and tend to still further obliterate any trace of the former polygonal outline the particular corallite may have possessed. Again, a parallel case may be seen in the figure of *Geinitzella columnaris*, Schl., sp., given by Waagen and Wentzel[1].

Messrs. Waagen and Wentzel have criticised[2] Prof. H. A. Nicholson's view that the acanthopores throughout the Monticuliporidæ are peculiarly modified corallites.[3] They regard them as newly-developed gems,[4] and remark as follows :—" The figure quoted above shows us a number of these spiniform corallites within the central portion of the colony as compact dark spots without hollows in the middle. In the same figure, however, we see more towards the peripheral region of the colony, just where the transition between the central and peripheral regions takes place, these so-called spiniform corallites opening out and transforming themselves into little tubes. These again become more and more widened, and at last become corallites of the common shape. From these observations it appears, beyond doubt, that a great part of the so-called spiniform corallites are nothing but newly-developed gems."

In the late edition of his " Palæontology," Prof. Nicholson has replied[5] to this, and I cannot do better than quote his words—" Waagen has expressed the opinion that the ' acanthopores' are only immature tubes, but this is conclusively shown to be erroneous by the fact that, while immature tubes can be readily demonstrated in *all* specimens, the ' acanthopores' are strictly confined to particular *species* of Monticuliporoids, and are uniformly absent in others. Moreover, they differ entirely in structure from the young tubes, and, unlike the corallites (whether young or old), they project above the general surface of the colony in the form of spines. Again, when they are limited in number, the acanthopores occupy definite positions as regards the ordinary tubes of the colony ; and, finally, in many forms.........the acanthopores are so numerous as to render the hypothesis that they are of the nature

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1 Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, t. 112, f. 4.
2 Pal. Indica, Salt Range Fossils, 1886, Vol. I, Part 6, p. 870.
3 Genus Monticulipora, &c., 1881, p. 46.
4 *i.e.*, young corallites.
5 A Manual of Palæontology, &c. Third Edition. By H. A. Nicholson and R. Lydekker, 1889, I, p. 349.

of young corallites quite untenable." The strongest point in this reply seems to me to be the numerical preponderance of the acanthopores in some sections. Granting, for the sake of argument, that the acanthopores are the initial stages of new corallites—they would during growth towards maturity so entirely crowd-out and distort the corallites, already on their way to senility, as to leave traces of such an exceptional growth in some form or another. No section of a *Stenopora*, which has come under my notice, has presented any trace of such an inordinate growth of young corallites.

In transverse sections young tubes may be distinguished usually nestling at the angles of the more mature corallites, similar in structure and appearance, but usually triangular, quadrangular (oblong or rhomboid), or pentagonal. They share with the older tubes the phenomena of thickened walls, and the presence of a secondary deposit within them. Much more rarely, young tubes appear as a portion of an older corallite partitioned off by a more or less direct line. In those species in which periodic growth is frequent and rapid, a large proportion of the newly-developed corallites do not appear to reach maturity.

Reproduction in *Stenopora* takes place generally by intermural gemmation, at rare intervals by fission. The young corallites mentioned above, in the first category, are the result of intermural gemmation, which consists in a subdivision or splitting of the primary wall of one or more corallites, and the gradual production therefrom of a similar tube. Young corallites which appear in a horizontal section as partitioned off from an old one are more probably the result of fission. Fissiparity consists of a longitudinal and internal subdivision of a mature corallite, resulting in the production of two, at first within the space originally occupied by the one. Intermural gemmation can be studied with advantage in sections, and longitudinally-fractured examples of *S. crinita* and *S. ovata*, but more particularly the former (Pl. V, Fig. 2)[1]. Fissiparity has been observed in a few instances also in *S. crinita*.

The walls of *Stenopora* are imperforate, as the researches of Messrs. Waagen and Wentzel have conclusively shown. It will be remembered that the late Prof. de Koninck[2] was the earliest writer to describe perforated walls in *Stenopora*[3], in a species he referred to *S. ovata*, Lonsdale, and, in consequence,

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[1] This figure has by inadvertence been reversed, giving to the new interpolated tube the appearance of proceeding downwards instead of upwards.

[2] Foss. Pal. Nouv. Galles du Sud., 1877, Pt. 3, p. 156, t. 7, f. 5 & 5*a*.

[3] De Koninck's enlargement, Fig. 5*a*, certainly represents a *Stenopora*, but the determination of Fig. 5 is very questionable. It bears a much closer resemblance to *Trachypora Wilkinsoni*, mihi.

transferred the latter to *Favosites*. Following him, Prof. H. A. Nicholson and the Writer most certainly observed pores in the coral named by us *S. Jackii*[1], and believed them to exist in *S. ovata*, nobis (non Lonsdale). In our later researches, however, embracing a review of all the Australian species, our views with regard to the perforation of the walls in *Stenopora* were much modified, but we were still perplexed by the occasional appearance of rounded apertures in longitudinal sections, both of *S. ovata*, Lonsdale, and *S. australis*, nobis, which were probably of this nature. In consequence of this we wrote as follows:—" The marked resemblances between the *Stenopora* and certain of the Monticuliporoids has led us to think that too great weight has, perhaps, been attached by De Koninck, as also by ourselves, to the value of the "mural pores" as a character of classificatory value. There can be no doubt that the walls of the corallites in some (and probably in all) of the species of *Stenoporæ* are pierced by irregular mural pores, and hence we have formerly referred the genus to the Favositidæ. In all other points except this, the species of *Stenopora* are, however, most nearly related to the Monticuliporoids. . . ."[2]

It would certainly appear from the careful later researches of Messrs. Waagen and Wentzel that the presence of pores in *Stenopora*, in the sense in which they are generally employed in the Favositidæ, cannot be upheld, and both Prof. Nicholson[3] and the Writer are prepared to abandon these structures as a distinguishing feature of the genus, leaving to future researches to determine the occasional appearance of mural openings in the species mentioned above, and their regular occurrence in *Stenopora Jackii*. An examination of the fine series of *S. crinita* in the Mining and Geological Museum has convinced me that the walls of this species are also imperforate—in fact, it was the thorough investigation I was able to give this species that brought home to me the general accuracy of Messrs. Waagen and Wentzel's observations.

These authors explain the rounded apertures observed by Prof. H. A. Nicholson and the Writer by supposing them to be, when seen in longitudinal sections, " the transverse section of some of those protuberances which have been called rudimentary septa in the Favositidæ or Chætitidæ." To this I cannot subscribe, never having seen the least trace of septal spines, or other mural development resembling them, in any species of

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[1] Ann. Mag. Nat. Hist., 1879, IV, pp. 270 and 275.

[2] Ann. Mag. Nat. Hist., 1886. XVII, p. 174.

[3] Letter dated June 4th, 1888. (Also see Manua of Palæontology, 1889, I, p. 357.)

Stenopora examined. As regards their figure,[1] to which these observers refer in confirmation of their opinion, the openings there represented seem much too irregularly distributed for septal spines, and do conform to the irregular arrangement assumed by the supposed pores in the species before mentioned. Neither septa nor pseudo-septa have revealed themselves in any section of *Stenopora* examined by me.

Tabulæ in the Australian forms of *Stenopora* appear to follow two well-established rules. In the axial region they are few in number, and remote; in the peripheral zone, either numerous and close, or comparatively absent. In *Stenopora crinita* one of these terms is hardly applicable, for we are not acquainted with a peripheral region in this species, in the same sense as in the others, but should rather speak of an axial region and periodic growth stage. In the former tabulæ are certainly remote, but are placed at the same level in contiguous tubes, corresponding to the distant fusiform thickenings and accompanying constrictions. At the termination of the latter the tabulæ increase greatly in number, corresponding to the more frequent thickenings; and probably, could we obtain a perfect example, it would be found that tabulæ occurred at all of these points in *S. crinita.*

In *Stenopora ovata*, *S. tasmaniensis*, and *S. australis* the tabulæ of the axial region follow the structure described in *S. crinita*, except that they are usually single and scattered. In *S. Leichhardti*, I am not acquainted with axial tabulæ, and only in the peripheral zone in the figure given by Prof. Nicholson and the Writer.[2] It is clear that tabulæ are very rare in this species, but whether structurally so, or from its peculiar state of preservation, I am not in a position to say. In the latter portion of the corallum in *S. ovata*, and probably also in that of *S. australis*, the tabulæ occur in such well-preserved examples as the Tasmanian specimens, frequently at the points of constriction, and on the same level with one another. But in the case of the former species caution must be exercised so as not to confound the true tabulæ with the foldings of sclerenchyma previously mentioned, which occur in the corallites of this species. Lastly, in *S. tasmaniensis*, the massively-thickened condition of the peripheral layer of the corallum renders a view of the tabulæ almost impossible. It is, however, probable that they are closely packed together.

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[1] Pal. Indica, Salt Range Fossils, 1886, Vol. I, Pt. 6, t. 111, f. 1c.

[2] Ann. Mag. Nat. Hist., 1886 XVII, t. 3, f. 8.

The tabulæ of the Australian species appear to me to be undoubtedly complete, and their concavity is downwards. I have never seen an instance of a perforated tabula in the proper sense of the word, and I believed that the supposed incomplete tabulæ seen by Prof. Nicholson and the Writer in *S. australis*[1] are capable of explanation, by regarding the secondary infilling of the tubes in this and other species as of *post-mortem* origin, or, at any rate, accumulated under exceptional circumstances. Under the specific description of *S. tasmaniensis* it will be explained that the final closure of the mouths of the corallites cannot be explained in the sense of perforated tabulæ. The misconception which may arise in connection with the closure of tubes by the zooids at the final period of growth is well explained by a study of the tube infillings of *Stenopora crinita* (Pl. III, Fig. 6; Pl. VI, Fig. 3). Many of the tubes would, on a superficial examination, be pronounced as so closed, but the structure here exhibited arises from a regular concentric deposit of mammillated or concentrically-laminated carbonate of lime, with the edges of the layers cut across. A longitudinal view of the deposit in the corallites of the same species further explains its phenomenon (Pl. VII, Fig. 1.)

In the article last referred to we pointed out how these supposed perforated tabulæ differed from the undoubted structures of this nature in *Stenopora Howsei*, Nich., in which the tabulæ are very numerous, bearing central apertures quite apparent in long sections. It is probably for a similar coral that Mr. John Young[2] has proposed the generic name of *Tabulipora*, but, excepting the structure of its tabulæ, it agrees in every way with that of *Stenopora*. We have already explained[3] that "if no other species of *Stenopora* possessed perforated tabulæ there would be ground for accepting *Tabulipora* as a sub-genus of *Stenopora*, or, perhaps, as a distinct genus." The view here adopted of the tube infillings of *S. australis*, and the final closure of the mouth in *S. tasmaniensis*, will remove the doubts hitherto existing as to the validity of *Tabulipora*, which must be restored to its place as a distinct and separate genus.

The nearest allies of the genus *Stenopora* are *Geinitzella*, and the above-mentioned *Tabulipora*. The distinction between the first and the last of these genera has just been indicated. That between *Geinitzella* and *Stenopora* appears to me to rest on a very slender basis, and to require further

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[1] Ann. Mag. Nat. Hist., 1886, XVII, p. 176.
[2] Ann. Mag. Nat. Hist., 1883, XII, p. 154.
[3] Ann. Mag. Nat. Hist., 1886, XVII, p. 177.

investigation. Messrs. Waagen and Wentzel, the describers of the genus[1], appear to rely for the separation of it by the absence of "the strong periodical thickenings of the walls of the corallites, so very conspicuous in Stenopora," and by "transverse wrinkles which are chiefly conspicuous on the internal casts." If I correctly understand these authors, this separation seems to me a very artificial one, and for two simple reasons:—1st. Periodical thickenings are absent in at least one presumed species of *Stenopora*, viz., *S. Leichhardti*, so far as we at present know its structure, the formation of the walls in this particular coinciding completely with that of their *Geinitzella*; they are confluent in the peripheral region of *S. tasmaniensis*, and frequently approach this condition in *S. ovata*. 2nd. A transverse wrinkling is present on the internal surface of most species of *Stenopora*, and has been referred to more than once in preceding pages; and, unless I wholly misunderstand Messrs. Waagen and Wentzel's meaning, it is conspicuous in their own figures of *Stenopora*.

With regard to the range of the genus in time and space, if we eliminate *S. Howsei* as referable to *Tabulipora*, and accept *Geinitzella*, *Stenopora* is found only in Australia, Tasmania, and India. On the other hand, by retaining the first-named species in the genus, the range of the latter is extended to the Carboniferous rocks of Great Britain; and if *Geinitzella* cannot be satisfactorily separated from *Stenopora*, then its appearance in the Russian Permian rocks is assured. If *Geinitzella* be considered distinct, the geographical range cannot be extended to Europe. In the two first-named countries it is restricted to the Marine Series of the Permo-Carboniferous, whilst in India *Stenopora* is characteristic of the Productus-Limestones of the Salt Range Series. *Geinitzella* is confined to the latter horizon and the Permian. Whichever of the above views be ultimately adopted, *Stenopora* must be regarded as a genus having strong Permian affinities, and is one of those organisms relied on for establishing the close relation believed to exist between that formation and the uppermost Palæozoic marine beds of Eastern Australia and Tasmania.

Some confusion appears to exist in connection with the species believed to exist in New South Wales. I am acquainted with three which have been described by former Writers—*S. ovata*, *S. tasmaniensis*, and *S. crinita*—but I have failed to identify *Stenopora gracilis*, Dana.[2] Prof. De Koninck described

[1] Pal. Indica, Salt Range Fossils, 1886, vol. I, Part 6, p. 880.

[2] *Chætetes*, Wilkes' U. S. Explor. Exped., 1849, Vol. X, Geology, p. 712, Atlas, t. 11, f. 10.

a branching coral from Glen William and Burragood, which he referred to *S. ovata*, but the presence of pores induced him to place it in *Favosites*.[1] This has already been explained, and will be referred to again later.

It is possible, and even probable, that all the species which have been described from Australasia do not represent separate and distinct organisms—I am inclined to think they do not—but this much is certain, they do represent different conditions, which, so far as the specimens themselves are concerned, seem permanent within certain circumscribed areas, and, therefore, for all reasonable purposes, such specimens may be considered distinct, until actual demonstration shall prove the identity of any one with another. For instance, *Stenopora ovata*, Lonsdale, and *S. australis*, N. & E., are, to all intents and purposes, identical in general characters, but the former is known to possess acanthopores, the latter not; the peculiarity in this case being that no specimen of *S. australis*, so far examined from the Bowen River Coal-field, the only locality known for this coral, has been observed to possess acanthopores—yet, in the mind of the Writer, the two "species" seem to be one.

Australian type—Stenopora crinita, Lonsdale.

STENOPORA CRINITA, *Lonsdale*.

Pl. II; Pl. III; Pl. IV, Fig. 2; Pl. V, Figs. 1–4; Pl. VI, Figs. 3–6;
Pl. VII, Fig. 1 and ? Fig. 2.

Stenopora crinita, Lonsdale in Strzelecki, Phys. Descrip. N. S. Wales, &c., 1845, pp. 91 and 265, t. 8, f. 5 and 5*a*.

Stenopora crinita, M'Coy, Ann. Mag. Nat. Hist., 1847, XX, p. 226.

Chætetes crinitus, Dana in Wilkes' U. S. Explor. Exped., 1849, X, (Geology), p. 711, Atlas, t. 11, f. 7.

Stenopora crinita, Nicholson & Etheridge, Junr., Ann. Mag. Nat. Hist., 1886, XVII, p. 182, t. 4, f. 1-5, p. 183, f. 2.

Stenopora crinita, Johnston, Geol. Tasmania, 1888, t. 21, f. 1, 1*a*. (Copied from Lonsdale.)

Sp. Char.—Corallum massive, globose or hemispherical, sometimes becoming gibbously lobate, with an undulating mammillated surface, composed of long corallites which radiate outwards gently towards the surface, and when seen in fractured sections present a plumose appearance, which is

[1] Pal. Foss. Nouv. Galles du Sud., 1877, Part 3, p. 156.

only broken by the series of strata into which the corallum is horizontally split up. In the axial region the corallites are basaltiform, but in the peripheral area more or less polygonal, or subpolygonal; in the former with occasional constrictions at long intervals, and in both transversely undulated with narrow periodic thickenings, as they approach each final period of growth. Average diameter of the corallites about half a millimeter. Periodical thickenings of the walls are narrow, ring-like annulations, comparatively wide apart, and separated by unthickened internodes, giving to longitudinal sections of the wall a characteristically moniliform aspect; but they appear to be most abundant and closer in the outer or peripheral zone. Acanthopores, as a rule, only developed in the thickened portions of the walls, usually at the angles of junction of the corallites, but occasionally in other parts of the former. Tabulæ very sparsely developed in the axial region, but comparatively numerous in the peripheral region, corresponding in general with the thickened annulations; they are complete and imperforate, and concave in a contrary direction to the growth of the corallites. Surface undulating, bearing monticules.

Obs.—The type specimen of this species is a mass about four inches and a half in length, composed of long basaltiform corallites, with a very gentle outward inclination, and evidently taken from the axial portion of a very large corallum. This specimen is now in the Geological Department of the Natural History Branch of the British Museum.

The corallum of *Stenopora crinita* at times undoubtedly attained to a very large size; large masses, to the naked eye, having a wonderful resemblance to the large *Chætetes radians*, Fischer, of the Russian Carboniferous Limestone. Dana mentions[1] a specimen of *S. crinita* six inches in diameter. A similar one to this is in the Collection, and another five inches in diameter. The corallum is invariably large, forming hemispherical, globose, massively tabular expansions, with an undulating surface, at times rising into lobate extensions, and almost becoming digito-palmate, but, so far as known, never ramose. Irregularities in growth sometimes occur, but the coral appears to have possessed a great facility for recovering the direction of its growth. The corallites are sometimes deflected from their course, immediately above a periodical cessation of activity, represented by the moniliform constrictions; but the original line or direction of growth is almost always recovered.

[1] Wilkes' U. S. Explor. Exped., 1849, Vol. X, Geology, p. 711.

The surface of a corallum, representing its absolutely final period of growth, has not been observed, but the outline was certainly undulating, and was in all probability covered with "monticules." The present surface (Pl. II, Fig. 1) of a fine radiating mass most distinctly shows these (Pl. 5, Fig.1), and it is not improbable that this character led Prof. F. M'Coy to describe *S. crinita* as with a "mammillated surface like that of the *Ceriopora verrucosa* Goldf.)."[1])

The monticules measure, as a rule, about two lines in diameter, and are separated from one another by the same distance, or even three lines. The corallites composing them do not appear to materially differ from the others in size. It may be that the groups of corallites of smaller size, described by Prof. Nicholson and the Writer as seen at tolerably regular intervals in sections, may be those corresponding to the monticules at the surface.

The growth of the corallum was periodic, even from its youngest stages (Pl. III, Fig. 1). Indeed, this appears to be a character incidental to the whole group of *Stenoporæ*, but is particularly characteristic of this species. The entire corallum is stratified in layers of very regular thickness (Pl. II, Figs. 1 and 2), a feature excellently shown in Lonsdale's original figure,[2] and referred to by Dana in the following words:—"They" (*i. e.*, the corallites) "separate rather easily, and are singularly regular in form, with few constrictions from irregular growth, and these commonly very slight, and in concentric lines, which sometimes give a specimen the appearance of being made of successive tiers of columns."[3]

The strata in *S. crinita* vary from three to ten millimetres in height, and so marked a feature is this stratification that, unless great care be taken, specimens in the slightest degree weathered break up along these planes. It is possible in certain states of preservation to peel off the strata, corallite by corallite, leaving an entirely new surface exposed after each operation. *Stenopora crinita* was, in all probability, attached by the whole of the base (Pl. III, Figs. 1 and 2), that is to say, the object which any individual particularly favoured was entirely coated or surrounded by it. The specimen represented in Pl. III, Fig. 1, has selected a *Streblopteria*, and has spread out from that in a concentrically circular manner, stratum upon stratum, until a base has been produced differing little in general appearance from some Favositoid corals. Other specimens in the Collection have attached themselves to univalve shells, and completely invested them.

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[1] Ann. Mag. Nat. Hist., 1847, XX, p. 226.
[2] Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, t. 8, f. 5.
[3] Wilkes' U. S. Explor. Exped., 1849, Vol. X (Geology), p. 711.

The average diameter of the corallites is about half a millimetre; they are polygonal in the peripheral region, basaltiform in the axial portion, and possibly not in close contact throughout. The external aspect of the corallites in fractured specimens is very characteristic. The first point to strike the eye is the basaltiform outline, with the gradual appearance of crenulations, or moniliform swellings, as the upper surface of each successive stratum or colony is approached (Pl. II, Figs. 1 and 2). This applies to the tubes whether in the peripheral or axial region, it being a mistake to suppose that these are confined in a greater degree to the former area. In the axial region, however, the annulations are not seen in the central portion of an internode, but only at the final period of growth, but generally when the internodes are long the annulations are single, as originally figured by Lonsdale, or at the most two or three. At the terminal stage in each colony, like those in the peripheral area, they become closely contiguous, and are specially numerous when the strata are short. In Pl. V, Fig. 3, are represented two corallites, viewed from the interior, in which the thickened ring, giving rise to a moniliform expansion, is plainly visible.

The primordial wall, or test, must have been very thin, shelling off in our fractured specimens as a thin pellicle.

As already explained in the generic description, the tubes do not appear to have been in absolute contact throughout, but a very thin space seems to exist between them. In Pl. V, Fig. 4, this is illustrated, the black central infilling between contiguous corallites being the separating medium, bounded by the lighter-coloured walls of the tubes, and the cavities of the latter again filled with darker matrix.

No better illustration of the variability in the thickness of the walls in *Stenopora* can be afforded than in the structure of the present species. Here the width of the walls varies according as the plane of the section corresponds with the thickened nodes, or traverses the unthickened internodes. In Pl. VI, Fig. 4, the abrupt passage from one to the other is clearly shown, but in many specimens the entire absence of nodes is a marked feature. In the majority of examples of *S. crinita* the thin proper walls of the corallites are usually lined by a continuous investment of calcareous substance, in this particular instance brown, of variable but usually considerable thickness. This investment is so invariably present, is so constant within certain limits in its thickness, and so exceedingly regular in its development that it possesses every feature presented by the layer of secondary sclerenchyma which is deposited on the inside of the proper wall of *Pachypora*, *Laceripora*, and other similar corals.

This secondary deposit is invariably similar in every corallite of an individual specimen, both in character and amount. In one specimen it may be of considerable width, and very dark in colour; in another narrow and pale, but there is no commingling of the two kinds. The smallest intercalated tubes follow the same rule. It is carried to the greatest extent, throughout the suite of specimens examined by me, in one from Singleton, wherein the tubes are all but choked up by it, leaving only the smallest particle of clear crystalline calcite in the centre. The investing nature of this deposit cannot be better studied than in transverse sections (Pl. III, Fig. 6), when it appears as a vertical crust completely lining the proper walls of each corallite. When *S. crinita* is devoid of this secondary deposit, the tube walls are very uniform in appearance, clear and distinct, forming a remarkably regular and constant network. Touching the nature of this deposit, the following is the conclusion of Prof. Nicholson and the Writer:—" This curious investment, in spite of its extraordinarily regular development, is of inorganic origin, and is produced by a *post-mortem* deposition of carbonate of lime within the cavities of the tubes. We have been led to this conclusion principally by two considerations. In the first place, we found that in one specimen of *S. crinita*, as above described, this secondary lining of the tubes had no existence at all. In the second place, we found that in another specimen of the same species this singular brown lining was present, but was irregular in its development, terminating in a ragged free edge where it surrounded the visceral chamber."[1] In Pl. III, Fig. 6, this infilling investment is exceedingly well shown from a calcareous and naturally-weathered specimen. On the upper left and towards the lower centre of the figure four corallites will be noticeable as nearly completely closed.

Well-marked acanthopores are at times placed at the angles of junction of the corallites, but their presence is by no means regular. They are sometimes minute, but at other times large, circular, thick-walled, and showing a distinct lumen. In the type specimen in London they are plainly visible in all the sections made, but in a number of the specimens contained in our Collection their presence is uncertain, although at times they can be detected.

[1] Ann. Mag. Nat. Hist., 1886, XVII, p. 184.

In some specimens, here and there, at tolerably regular intervals, may be observed groups of comparatively small-sized corallites, with thicker walls and larger acanthopores. An explanation of this has already been offered on a previous page.

The presence of tabulæ is an equally variable feature with the acanthopores in *S. crinita*. They are developed from the nodal points, sometimes very few, or none, being present in one set of tubes, whilst, on the other hand, they may be developed from almost every successive pair of nodal points in another series. Furthermore, the tabulæ appear to be complete (Pl. VI, Fig. 6, Pl. VII, Fig. 1.)

The chief specific points which may be employed for the determination of *Stenopora crinita* are—1. Its massive rounded and lobate outline; 2. The highly stratified mode of growth, whether in the axial or peripheral regions; 3. The presence of long internodes between the moniliform swellings, as compared with those of other species; 4. Complete and imperforate tabulæ; 5. Presence of monticules; 6. Acanthopores, when present, developed at the angles of the corallites, rarely elsewhere.

Some doubt has hitherto existed in the minds both of Prof. H. A. Nicholson and the Writer[1] regarding the specific value of *Stenopora informis*, Lonsdale.[2] Only two specimens are known to me, which can, with any possible certainty, be referred to this coral—the type in the British Museum, London; the other a very beautiful fragment from near Hobart, Tasmania, presented by Mr. John Waterhouse, M.A. The moniliform annulations are so strongly marked, as close set rings placed invariably at corresponding levels throughout the corallum, added to the fact that a marked difference exists in the size of the corallites—one-third millimetre in the case of *S. informis*, and one-half millimetre in *S. crinita*—that it is still necessary, in the absence of further details, to retain the species separate. The height of the Tasmanian specimen referred to is one inch, and throughout this extent the swellings are crowded together with the greatest compactness, but still retaining their perfect outline and shape. They are much more distinct and regular than those of *S. crinita*, and throughout the specimen do not show any of the comparatively long internodes of that species. Is it possible that we have here the final period of growth of *S. crinita?*

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[1] Ann. Mag. Nat. Hist., 1886, XVII, p. 181.

[2] Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, t. 8, f. 4 & 4*a*.

Locality[1] *and Horizon.*—Hunter River Railway Bridge, Singleton, Co. Durham (*Messrs. T. W. E. David, B.A.*, and *S. Dodds*); Bow-wow, Mount Vincent, Co. Northumberland (*T. W. E. David, B.A.*); Shoalhaven, Co. St. Vincent (*C. Cullen*); Creek half-a-mile south-west of Dapto, Co. Camden (*C. Cullen*); Railway cutting under Wollongong Road, Wollongong, Co. Camden (*S. Alexander*); Coast, about one mile south of Jerringong, near Kiama, Co. Camden (*E. C. Whittle*) :—**Upper Marine Series.**

Stenopora ovata, *Lonsdale.*[2]

Pl. V, Figs. 5 and 6; Pl. VI, Figs. 7 and 8; Pl. VII, Figs. 3-6.

Stenopora ovata, Lonsdale, in Darwin's Geol. Obs. Volc. Islands, 1844, p. 163.

Stenopara ovata, Lonsdale, in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 263, t. 8, f. 3–3*b*.

Stenopora ovata, M'Coy, Ann. Mag. Nat. Hist., 1847, XX, p. 226.

Chætetes ovata, Dana, in Wilkes' U. S. Explor. Exped., 1849, Vol. X, Geology, p. 712, Atlas, t. 11, f. 9, 9*a* & *b*

Stenopora tasmaniensis, Nicholson, Tab. Corals, Pal. Period, 1879, p. 281, f. 3 A & B.

Stenopora ovata, Nicholson and Etheridge, Junr., Ann. Mag. Nat. Hist., 1886, XVII, p. 173, t. 3, f. 1–4.

? *Stenopora ovata,* Waagen and Wentzel, Pal. Indica, Salt Range Fossils, 1886, Vol. I, Pt. 6, p. 888, Atlas, t. 110, f. 1–3.

Stenopora ovata, Johnston, Geol. Tasmania, 1888, t. 21, f. 4, 4*a*. (Copied from Lonsdale.)

Sp. Char.—Corallum large, ramose, spreading dichotomously; branches cylindrical or sub-compressed, from a quarter to one inch in diameter, decreasing in size but little towards their apices; stratification usually visible only in the peripheral zone. Corallites polygonal in the axial region, becoming cylindrical in the peripheral area, the angle of deflection being sharply marked, at times almost becoming a right angle; viewed transversely the corallites are long-oval, rounded, or sub-polygonal, from one-third to half a millimetre in diameter. Periodical annulations absent in the axial region; numerous, close-set, and sub-pyriform in the outer zone, but when this zone is much extended becoming confluent.

[1] By Count P. de Strzelecki, *S. crinita* was recorded from Illawarra, in limestone (Phys. Descrip., N. S. Wales, 1849, p. 91); by Prof. F. M'Coy from Wollongong, in sandstone, Darlington, in sandstone, and Black Head, Illawarra, in calcareous beds (Ann. Mag. Nat. Hist., 1847, XX, p. 226); and by Prof. J. D. Dana, at Wollongong Point, Illawarra (Wilkes' U. S. Explor. Exped., Vol. X, 1849, Geology, p. 711).

[2] Non *Stenopora ovata,* Nicholson and Etheridge, Junr., Ann. Mag. Nat. Hist., 1879, IV, p. 274.

Primordial wall distinct, delicate, sometimes becoming thickened. Acanthopores usually developed at the angles of junction of the corallites, and when so few in number, of large size, and forming blunt spines at the surface; at times greatly developed in the thickened portions of the walls, when their situation is variable. Tabulæ complete, few, and remote, in the axial region; becoming closer in the peripheral zone.

Obs.—The type specimen of *S. ovata*, like that of *S. crinita*, is preserved in the Geological Department of the British Museum—that is to say, the specimen which must be regarded as the type—for the original coral on which Lonsdale founded the name, and collected by the late Dr. Charles Darwin, has been lost in the passage of time—is retained therein, and is that figured by Lonsdale in Strzelecki's work.

The corallum is dichotomously branched, and must have attained some size, as the type measures four inches in length, and is clearly only a portion of a much larger example. Individual branches retain their size throughout, very little diminution in diameter taking place towards their apices, and thus giving to the corallum a marked and probably specific appearance. Branches have been observed as small as a quarter of an inch, and as large as an inch in diameter, with the apices blunt and rounded, but examples with the axial region removed, leaving a hollow cylinder represented by the peripheral zone, have not come under notice, except from Tasmania.

As might be expected from its mode of growth, stratification, as a rule, does not take place in the axial region, nor to any extent in the outer zone, in our New South Wales specimens until the periphery is approached. The figured type does, it is perfectly true, as in all Tasmanian examples I have seen, show such demarcation in layers in the central zone.

Nothing is known of the mode of attachment in this species, but judging from analogy, the base will probably be found to be encrusting rather than enveloping.

The persistent manner in which the matrix invariably adheres has rendered it almost impossible to observe the surface characters at a final period of growth. On one coral from Singleton, however, the mouths of the corallites are either round or polygonal, and the cell walls rather more thickened than when seen in transverse sections of the peripheral region. Neither monticules, nor clusters of smaller cells, have been noticed. The interstitial, or inter-calicular surface, is always large in this species.

The corallites, after their divergence from the axial region, lose much of their polygonal form, and become to some extent cylindrical. The preservation of the proper wall and line of demarcation between the corallites varies much according to preservation, but, as a rule, they can be satisfactorily made out. In an exceptionally good section of this species may be seen the primordial wall, the secondary organic thickening, and the inorganic investment (Pl. VII, Fig. 3). There is but little difference in a transverse axial section between this species and *S. crinita*, excepting in the size of the corallites; there is the same form, same condition of the walls, and the same secondary inorganic deposition around the walls. In a transverse section of the peripheral region the periodical thickenings succeed one another more rapidly in succession, and they are more strictly moniliform, or even pyriform, than in *S. crinita*. It is, however, in a longitudinal axial section that the greatest differences are observable, the corallites of *S. ovata* so far examined by me being here entirely destitute of constrictions or swellings, and are practically non-tabulate also. The moniliform swellings of the walls vary to some extent from being moderately distant[1], to a rapid succession of one another, and they are at times semi-confluent, more especially in Tasmanian examples, but in such cases do not entirely lose their moniliform outline, as in the case with *S. tasmaniensis*.

In Pl. VII, Figs. 2 and 3, the insensible manner in which the original wall passes into a thickened portion, and becomes lost, is excellently shown, but now and then it can be equally distinctly traced in the latter.

In position and structure the acanthopores (Pl. VII, Figs. 2 and 4) are very similar to those of *S. crinita*, and when present usually occupy the angles between contiguous cells; but at times, especially in Tasmanian examples, are scattered on the intermediate boundary walls rather thickly, although never clustered there as in *S. tasmaniensis*. They are circular, very strongly-developed and with thickened walls, and a distinct lumen. In a very interesting section (Pl. VII, Fig. 3), from a Singleton specimen, there is an instance of the development of acanthopores in thickened and unthickened walls, side by side; and, lastly, the central aperture usually occupies a very large part of the diameter. They have a general papillose appearance, the walls being concentric-laminar in structure. In vertical sections the acanthopores appear as rods running in the corallite walls, and in this species are very persistent.

[1] Ann. Mag. Nat. Hist., 1886, XVII t. 3, f. 2.

The tabulæ are complete, making their appearance soon after deflection of the tubes from the axial region, and gradually increasing in number and contiguity to one another as the surface is approached.

The chief points for specific determination are—1. The dichotomous method of branching; 2. The almost invariable presence of a large acanthopore at most of the angles of junction of the corallites, a character specially dwelt on by Lonsdale,[1] who mentions that there is only one "relatively large tubercle" in the "interspaces between four mouths"; 3. The absence of tabulæ in the axial region.

Amongst the synonyms of *Stenopora ovata* generally given by authors is the *Favosites ovata*, De Koninck.[2] The fossil there described as possessing pores cannot be accepted as a *Stenopora*, and as regards the figures there must be an error. De Koninck's Fig. 5 of the plate cited below represents corallites at least twice too large for those of *S. ovata*, but, on the other hand, Fig. 5*a*, said to be an enlargement of the former, distinctly shows moniliform expansions of the walls, after the manner of that species. Fig. 5, on the contrary, has far more the appearance of *Trachypora Wilkinsoni*, mihi, and the presence of pores will then be quite in accord with the structure of the latter; at the same time, the walls of the corallites are not annulated. As so much doubt, therefore, surrounds the identity of this fossil, I have not included it in the synonomy of *Stenopora ovata*.

In the beautiful figures of this species given by Messrs. Waagen and Wentzel the moniliform annulations are in places confluent. As previously stated, I have not observed this in any New South Wales, although it is apparent in Tasmanian examples; but, otherwise, the Indian form appears to coincide with that from our rocks.

A re-examination of the form called by Prof. Nicholson and the Writer *S. Leichhardti*[3] has shaken the Writer's faith in the distinctness of this as a species, and it may have to be referred to *S. ovata*. The chief point of difference relied on for their separation was the greater prevalence of acanthopores and their larger size in the former species, the long fusiform, and at times almost confluent periodical thickenings, and the very simple tube-like nature of the acanthopores. The examination of additional material

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[1] Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 264.

[2] Foss. Pal. Nouv. Galles du Sud, 1877, p. 156, Pt. III, t. 7, f. 5, 5a.

[3] Ann. Mag. Nat. Hist., 1886, XVII, p. 179. t. 3, f. 7 and 8.

of the latter species, especially from Tasmania, received through the courtesy of Mr. R. M. Johnston, F.L.S., seems to indicate that the fossils known under these names should be united. Anticipating other specimens of *S. Leichhardti* from Queensland for examination, this step is deferred pending such.

In our paper[1] "On the Tasmanian and Australian Species of the Genus *Stenopora*," Prof. H. A. Nicholson and the Writer referred to Tasmanian *Stenoporæ* having the general characters of *S. ovata* and *S. tasmaniensis*, but with a compressed corallum, the corallites radiating from both sides of a central plane. Mr. R. M. Johnston has forwarded me similar specimens from Porter's Bay, near Hobart, and Maria Island, respectively. That from the latter locality, and one example from the former, are certainly frondescent, *i.e.*, forming flattened tabular expansions of irregular form, as the specimens now lie on the surface of the matrix. Certain of the remainder from Porter's Bay exhibit the true characters of *S. ovata*, although a good deal compressed, but it is clear that they are simply compressed stems. On the other hand, a larger specimen resembling the latter in its general features may have a frondescent corallum, but its present exposure from the surrounding matrix is not sufficient to enable me to form a decided opinion. We may, therefore, conclude, tentatively, that there is the possibility of both *S. ovata* and *S. tasmaniensis* possessing an allied species in which the microscopic structure is very similar, but with a frondescent corallum. This point only future research can decide. Had it not been for corallites opening on both sides of a central plane, without definite signs of compression, I should have suggested the possibility of this being the base of attachment of *S. ovata*, but of course that one fact is fatal to such an idea, on the supposition of the base being encrusting. I am under the impression that the form resembling *S. tasmaniensis* will require to be separated from that species, and should investigations, now in progress on the structure of the Tasmanian *Stenoporæ*, confirm this supposition, I shall have much pleasure in calling it *Stenopora Johnstoni.*

This fossil, of course, brings forward the important question of how far outward form can be depended on for specific determination. To a certain extent there is no doubt it can—thus, the growth of *S. crinita* is in itself distinctive, as between it and other species, except *S. informis*, if this be a

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[1] Ann. Mag. Nat. Hist., 1886, XVII, pp. 175 & 179.

species. The ramose characters of *S. australis*, *S. ovata*, and *S. Leichhardti* are sufficiently marked to distinguish them from *S. tasmaniensis*, whilst the frondescent condition of the fossil above referred to, from Tasmania, is unlike any of the other Australian *Stenoporæ*.

Locality[1] *and Horizon*.—Hunter River Railway Bridge, Singleton, Co. Durham (*T. W. E. David, B.A.*); Maitland Vale, near West Maitland, Co. Durham (*R. W. Thompson, M.P.*):—**Upper Marine Series.**

Stenopora tasmaniensis, *Lonsdale*[2].

Pl. IV, Figs. 3 and 4; Pl. V, Figs. 7 and 8; Pl. VII, Fig. 9.

Stenopora tasmaniensis, Lonsdale, in Darwin's Geol. Obs. Volc. Islands, 1844, p. 161.

Stenopora tasmaniensis, Lonsdale, in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 262, t. 8, f. 2–2.

Stenopora tasmaniensis, M'Coy, Ann. Mag. Nat. Hist., 1847, XX, p. 226.

Chætetes tasmaniensis, Dana in Wilkes' U. S. Explor. Exped., 1849, X (Geology), p. 711, Atlas, t. 11, f. 7–8*a*.

Stenopora tasmaniensis, Nicholson and Etheridge, Junr., Ann. Mag. Nat. Hist., 1886, XVII, p. 178, t. 3, f. 9–12.

Stenopora tasmaniensis, Johnston, Geol. Tasmania, 1888, t. 21, f. 3–3*b*. (Copied from Lonsdale.)

(Compare *S. gracilis*, Dana, *Loc. cit.*, p. 712, t. 10, f. 15, *a–c*.)

Sp. Char.—Corallum dichotomously ramose, varying from three to eleven-sixteenths of an inch in diameter; branches cylindrical, but frequently swelling and decreasing in size during their course, especially towards their apices, sometimes contorted; peripheral portion of the corallum very narrow and much reduced, the axial region being correspondingly wide. Corallites deflected from the axial line at a very low angle, bending gradually and slowly outwards, polygonal in the axial region, becoming more cylindrical towards the periphery; calices oval, about one-third millimetre in diameter, disposed in slightly oblique rows, giving rise to a quincuncial arrangement, their longer axis corresponding with the long axis of the

[1] *Stenopora ovata* was first recorded as a New South Wales fossil by M'Coy, simply with the remark—ommon in Darlington Sandstone (Ann. Mag. Nat. Hist., 1847, XX, p. 226); Dana next noted its occurrence at Harper's Hill, near West Maitland (Wilkes' U. S. Explor. Exped., Vol. X, 1849, Geology, p. 712); and the late Rev. W. B. Clarke gave Singleton Bridge as a third locality (Sed. Form. N. S. Wales, 4th Edit., 1878, p. 135).

[2] Non *Stenopora tasmaniensis*, Nicholson, Tab. Corals Pal. Period, 1879, p. 281, f. 38.

corallum ; vestibules deep ; interstitial surfaces strongly angular. Acanthopores small, very numerous, forming a more or less complete ring round each calice, and placed on the angular interstitial surface, superficially appearing as oblique rows, or encircling rings of small tubercles, or minute apertures. Moniliform annulations, or periodical thickenings of the walls confined to the peripheral region, wide, and generally confluent towards the final period of growth, and thus becoming comparatively individually indistinct when separate, presenting an obconate appearance in sections. Tabulæ very sparingly developed, complete, but the calices sometimes closed by perforated diaphragms.

Obs.—In the case of this species identification has chiefly depended on Lonsdale's figure in Strzelecki's work, but the characters are so well marked that little difficulty has arisen in referring specimens to it. The figured example could not be found in the Department of Geology, British Museum, by the Writer.

As in *S. ovata*, the corallum is dichotomously branched, but, on the whole, *S. tasmaniensis* must be regarded as a less robust species than the form just named. The branches are sometimes enlarged and constricted in their course, and it not infrequently happens that the apices are hollow, from the apparent decay or disintegration of the corallites in the axial region. Lonsdale noticed[1] this peculiarity, and both he and Dana speak of specimens crushed completely flat, with the whole of the axial portion removed. The base of attachment has not been observed, at the same time the species attained some size, as Lonsdale mentions one four and a half inches in length.

As distinguished from *S. ovata* and *S. Leichhardti*, the peripheral region in the species now under description is remarkably narrow, arising chiefly from the very gentle angle at which the tubes diverge from the imaginary axis, the strong angle of deflection visible in other species being quite absent.

The corallites in the axial region are angular, but become cylindrical throughout their short peripheral course. The primordial wall is visible in the former, and throughout a considerable portion of the latter, as very little secondary organic thickening appears to have taken place until the periphery of the corallum is approached. It is rare to meet with moniliform

[1] Darwin's Geol. Obs. Volc. Islands, 1844, p. 161.

annulations except towards the final period of growth of the corallum where they are confluent and continuous with one another, not separated by marked unthickened segments, but forming a dense thickened peripheral layer along individual walls, presenting an obconate figure in section, which is very characteristic of the species. Annulations have been observed below this, and even one or two in the axial region, but these occurrences are rare. Sometimes the first, or the two first, in ascending order in the peripheral area, are separate, and distinctly formed; then succeeds the line of amalgamated annulations nearly continuous with one another.[1] The inorganic deposit, which forms such a prominent feature in *S. crinita* and *S. ovata*, is not developed to an extent in any way approaching that seen in those species, and at times is barely perceptible at all. In a Tasmanian specimen from One Tree Point it is entirely absent.

The surface features of *Stenopora tasmaniensis* are very characteristic of it. In a recent Memoir, Prof. Nicholson and the Writer pointed out that this species can be at once recognised amongst the other Australian forms by its long oval calices arranged in obliquely longitudinal rows, resulting in a quincuncial disposition of the apertures. The thickening previously described at the final period of growth along the line of close-set annulations extends to the outer surface, the calices being separated from one another by crestiform interstitial surfaces. The vestibules[2] of the calices are straight-walled or funnel-shaped, according to the development of the diaphragms which appear to close those of *S. tasmaniensis* at the final period of growth.

This partial closing of the tube mouths at maturity has been well described and figured by Lonsdale.[3] He says, "Where the mouth becomes free and oval, the walls are thin and sharp, and perpendicular within the tube. In some cases they are in contact; but in others they are separated by grooves of variable dimensions, in which very minute foramina or pores may be detected. As the mouth approaches towards maturity, the grooves are more or less filled up, and the walls thicken, a row of very minute tubercles being discoverable along the crest. At this stage the inner side of the tube ceases to be vertical, being lined by a very narrow inclined band. The mature mouths are separated by a bold ridge, generally simple, but not infrequently

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[1] Well shown in a figure by Prof. H. A. Nicholson and the Writer, Ann. Mag. Nat. Hist., 1886, XVII, t. 3, f. 10.

[2] This term is employed to denote that part of the calice cut off by the diaphragm, or, as it was termed by Lonsdale, the "band."

[3] Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, t. 8, f. 2*a*–2*d*. See also Nicholson & Etheridge, Junr., Ann. Mag. Nat. Hist., 1886, XVII, t. 3, f. 11 & 12

divided by a groove; the double as well as the single ridge being surmounted by a row of prominent tubercles almost in contact with each other. Only one example of the filling up of the mouths has been observed, but it affords satisfactory evidence of a gradual expansion of the inner band, before alluded to, and a final meeting in the centre."

Tabulæ are very sparsely developed, and are often not recognisable at all, but when present are undoubtedly complete. In Pl. VII, Fig. 9, two are visible just previous to the deflection of the tubes towards the periphery. By Prof. Nicholson and the Writer, the imperfect diaphragm of the vestibule was spoken of as a perforate tabula,[1] but lacking evidence as to the existence of true perforated tabulæ as they exist in *Stenopora (Tabulipora) Howsei*, Nich., it will be better, in the meantime, to refer to this structure as a perforated diaphragm only, without intending to convey by this term the homologue of a true tabula.

In our New South Wales rocks it seems to be particularly difficult to obtain specimens exhibiting the surface. This arises, possibly, from the tenacious manner in which the numerous prickle-like acanthopores adhere to the matrix. On the other hand, in Tasmanian examples the surface characters are usually well displayed, for the deposits in that island, characterised by *Stenopora*, appear to be more calcareous than do our Marine beds, and better adapted for the weathering-out of fossils. In *S. tasmaniensis* the acanthopores are very numerous, often forming a complete ring round the mouth of the calice,[2] as many as twelve having been counted in this position, on the somewhat angular interstitial surfaces. Or the acanthopores may be placed in more or less longitudinal oblique rows, similar to the calices, when the circular arrangement becomes gradually lost. When such is the case a depressed surface exists on the interstitial surface of the corallum, between contiguous rows of calices, giving rise to the appearance of a groove, as shown in another of Lonsdale's figures.[3]

The distinguishing points relied on for specific determination in *S. tasmaniensis* are:—1. The irregularity in the diameter of the branches, and its lesser size when compared with that of *S. ovata*. This is, perhaps, not a very stable character, as some specimens of *S. tasmaniensis* attain a fair development, but I think it may be accepted that, as a rule, it is smaller

[1] See Ann. Mag. Nat. Hist., 1886, XVII, t. 3, f. 12.
[2] Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, t. 8, f. 2 *a-c*.
[3] Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, t. 8, f. 2*d*.

than *S. ovata*. 2. The character of the acanthopores just described. 3. The narrow peripheral, and wide axial portions of the corallum. 4. The confluent moniliform expansions of the corallite walls. 5. The calice mouths sometimes partially closed by perforated diaphragms.

With regard to the synonomy, only two points need be touched upon. The figures given by Prof. H. A. Nicholson, in his "Tabulate Corals of the Palæozoic Period,"[1] under the name of *Stenopora tasmaniensis*, do not represent that species, but, as pointed out subsequently,[2] are referable to *Stenopora ovata*, Lonsd. I think it is possible that *S. gracilis*, Dana, sp., may be referable here. The long non-constricted corallites represented in Dana's Fig. 10*a* correspond better with those of this species than they do with those of any other; whilst the illustration of the corallite mouths, in his Fig. 10*b*, have a certain resemblance to some states of those of *S. tasmaniensis*, when the acanthopores are not visible.

Locality[3] *and Horizon.*—Summit of Harper's Hill, near West Maitland, Co. Northumberland (*C. Cullen*); Railway Cutting, Harper's Hill, ditto, (*C. Cullen*) :—Lower Marine Series; Gerringong, near Kiama, Co. Camden (*C. Cullen*) :—Upper Marine Series.

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[1] P. 281, f. 3, A & B.
[2] Ann. Mag. Nat. Hist., 1886, XVII, p. 175, *note*.
[3] Prof. M'Coy mentioned Darlington as a locality for *S. tasmaniensis*, in sandstone (Ann. Mag. Nat. Hist., 1847, XX, p. 226); Dana recorded it from a typical locality, Harper's Hill, near West Maitland (Wilkes' U. S. Explor. Exped., Vol. X, Geology, p. 711).

INDEX TO THE GENERA AND SPECIES.

EXPLANATION OF THE PLATES.

NOTE.—Unless otherwise stated, the figures are of the natural size.

PLATE I.

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Trachypora Wilkinsoni, Eth. fil. 26

Fig. 1. Portion of a branch showing the distribution of the corallites, and a central abortive branch, x $1\frac{1}{2}$.

Fig. 2. Portion of another branch, in which the septal ridges are better defined, x $1\frac{1}{2}$.

Fig. 3. Small part of a corallum on which the calices open in a contrary direction from opposite ends, x $1\frac{1}{2}$.

Fig. 4. Bifurcating corallum, naturally fractured, showing the corallites in section in the centre of the branches, with tabulæ *in situ*; the calice mouths around the periphery separated by the highly-thickened walls, x 2.

Fig. 5. Small part of Fig. 4 enlarged four times to show these characters more distinctly, x 4.

Fig. 6. Another stem naturally fractured, x 2.

Fig. 7. A stem partially split with the stellate calices admirably shown at the base, x $2\frac{1}{2}$

Fig. 8. Portion of a corallum, from which the whole of the calcareous matter has been dissolved, leaving the fluted internal casts of the corallites as inverted cones, connected by cross-bars which are the inorganic infilling of the pores of communication, magnified.

Figs. 1–6, from Mulbring.
7, „ Shoalhaven.
8, „ Boorook.

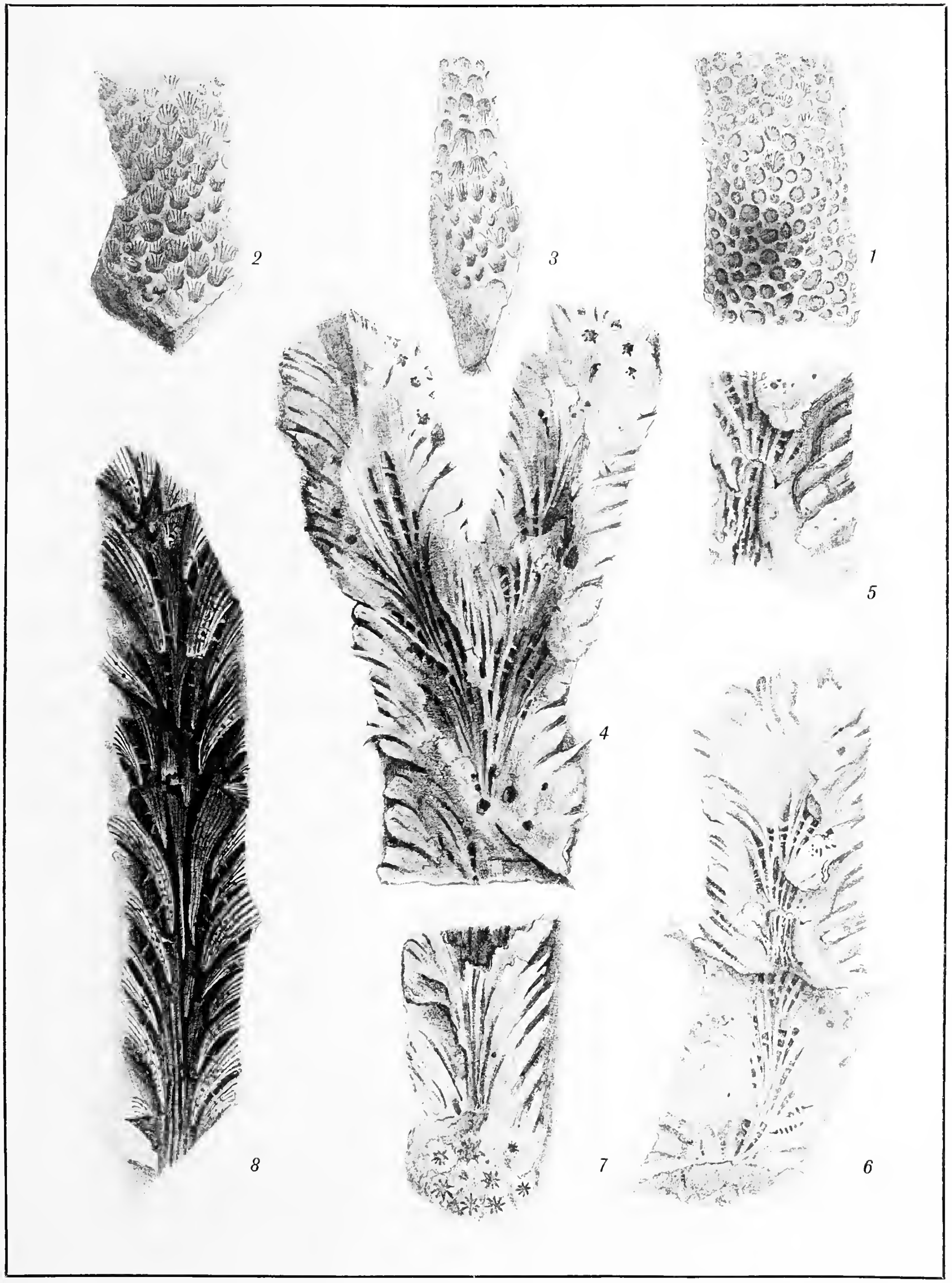
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PLATE II.

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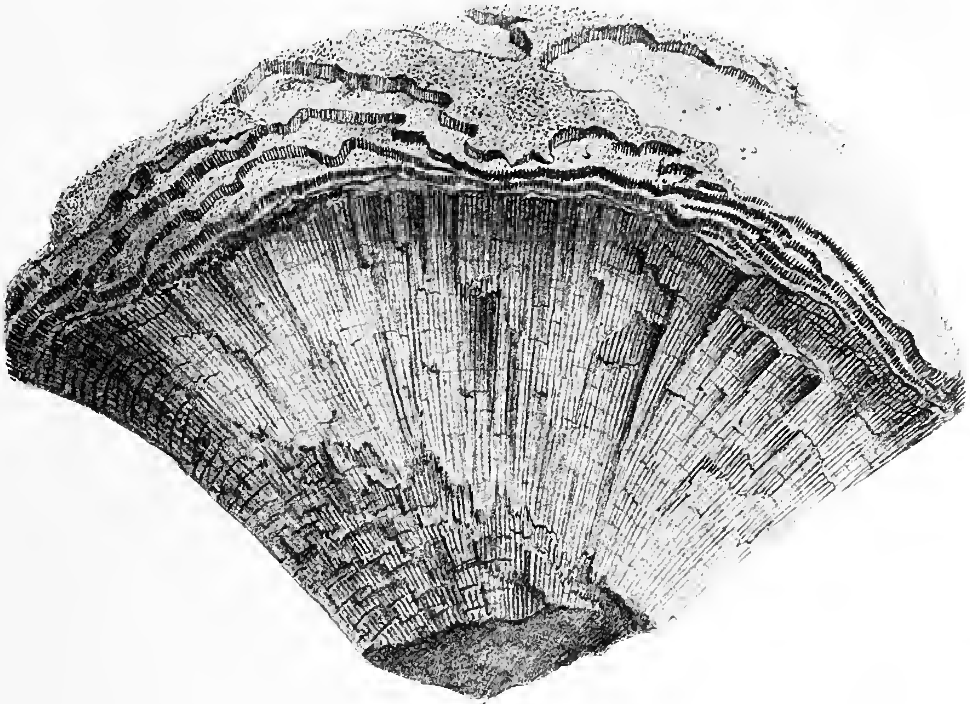
Stenopora crinita, Lonsdale... 49

Figs. 1 and 2. Portions of a fine hemispherical mass, exhibiting the long prismatic corallites radiating from an imaginary axis, and the concentric layers of tubes representing periodical stages of growth.

Wollongong.



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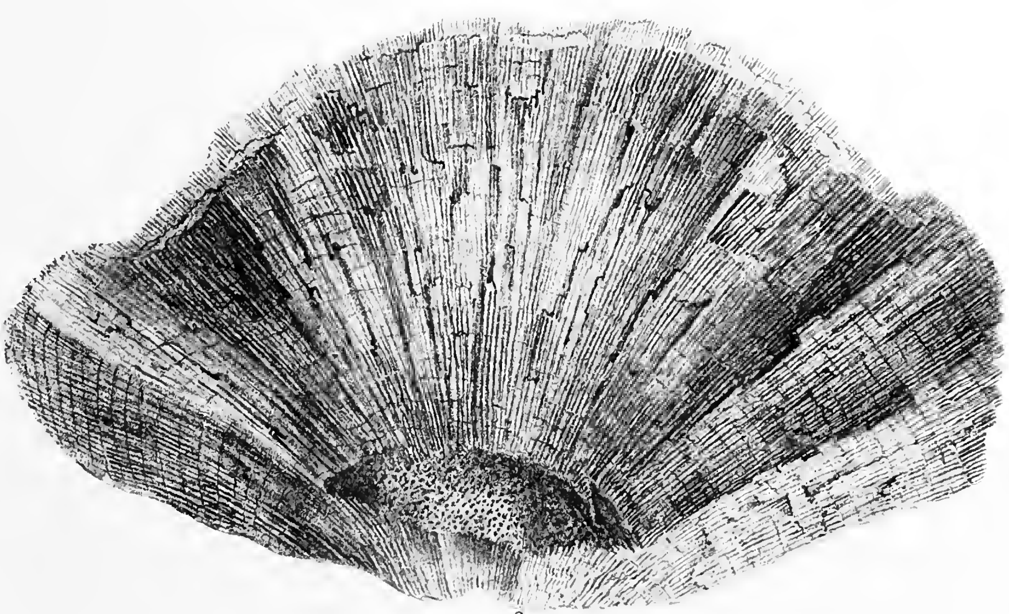

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PLATE III.

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Fig. 1.	Base of a circular corallum showing the gradual superimposition of the various colonies composing it, from the original attached to one of the Aviculopectinidæ, probably *Streblopteria*.	
Fig. 2.	Hemispherical example, fractured, adherent to an organism, now partially removed, probably a univalve.	
Fig. 3.	Portion of a fractured lobate specimen.	
Figs. 4 and 5.	Series of tubes taken from different specimens, showing the stratified condition of the corallum generally, the distant moniliform constrictions, and crenulated surface, x 6 and 7 respectively.	
Fig. 6.	Weathered surface of a lobate fractured example, showing the various degrees of closure of the corallites by the secondary deposition of sclerenchyma, x 12.	

Wollongong,

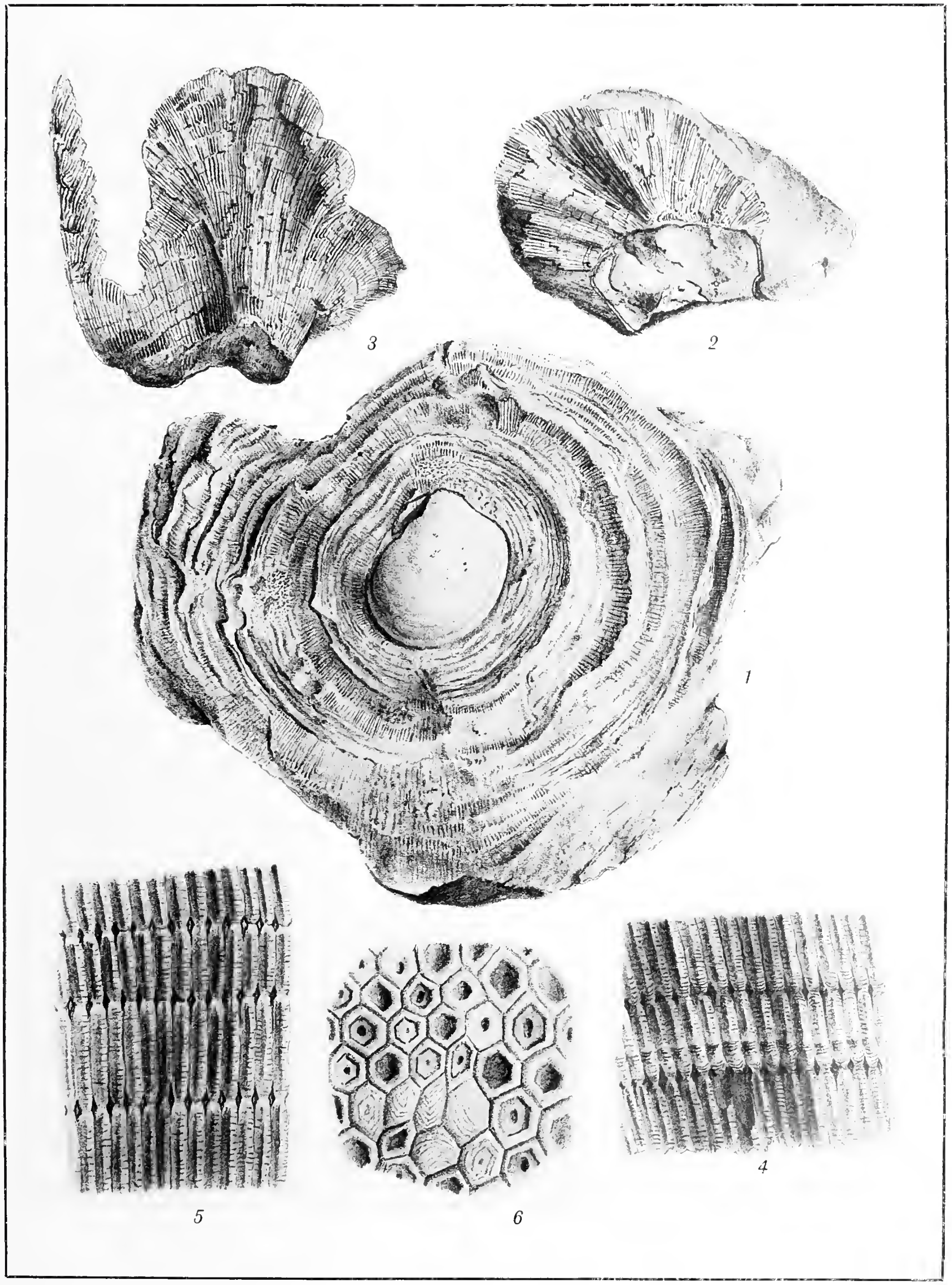
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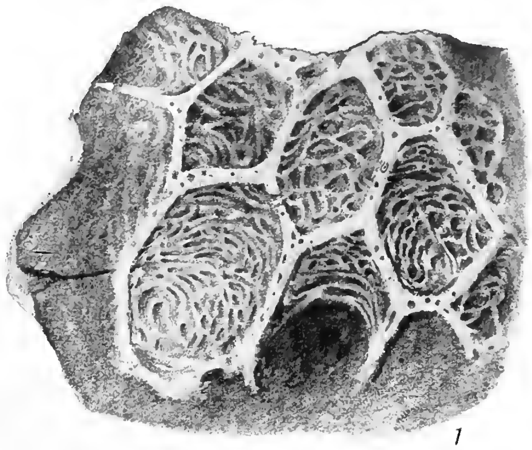
PLATE IV.



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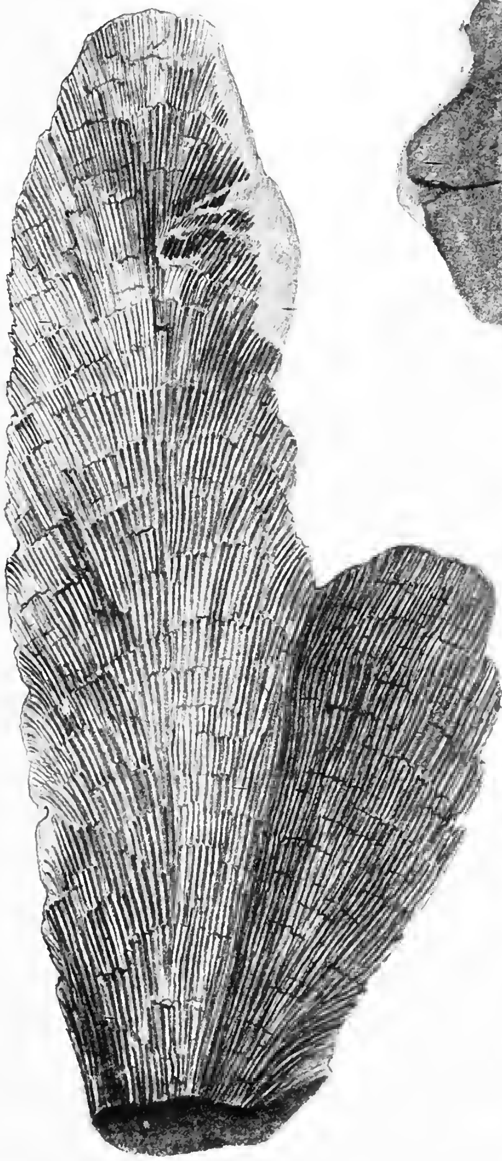

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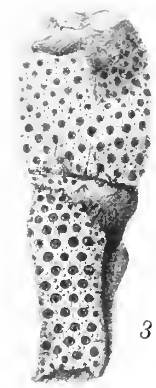

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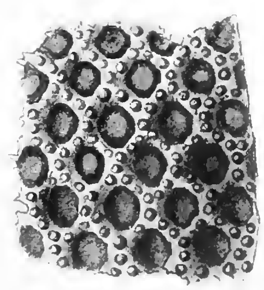

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PLATE V.

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	Stenopora crinita, Lonsdale	49

Fig. 1. A small portion of the surface of the specimen figured Pl. II, Fig. 2, with monticules, x. $\frac{1}{2}$.

Fig. 2. Parts of six corallites to show the interpolation of a new tube (This figure should be reversed), x. 4.

Fig. 3. Corallites naturally fractured, seen from the inside, to show moniliform constrictions, and partially filled-up mouths in a lower colony, x. 4.

Fig. 4. Three corallites from a weathered naturally-fractured surface, x 4.

Stenopora ovata, Lonsdale 55

Fig. 5. Part of a branched corallum, giving general features, with peripheral moniliform constrictions.

Fig. 6. Portion of Fig. 5 to show these features more distinctly, x. 3

Stenopora tasmaniensis, Lonsdale 60

Fig. 7. Portion of a corallum, with method of branching, &c., fractured and weathered.

Fig. 8. Part of the surface of Fig. 7, x. 3.

Figs. 1, 4, from Wollongong.
2, 3, 5, 6, „ Singleton.
7, 8, „ Gerringong.

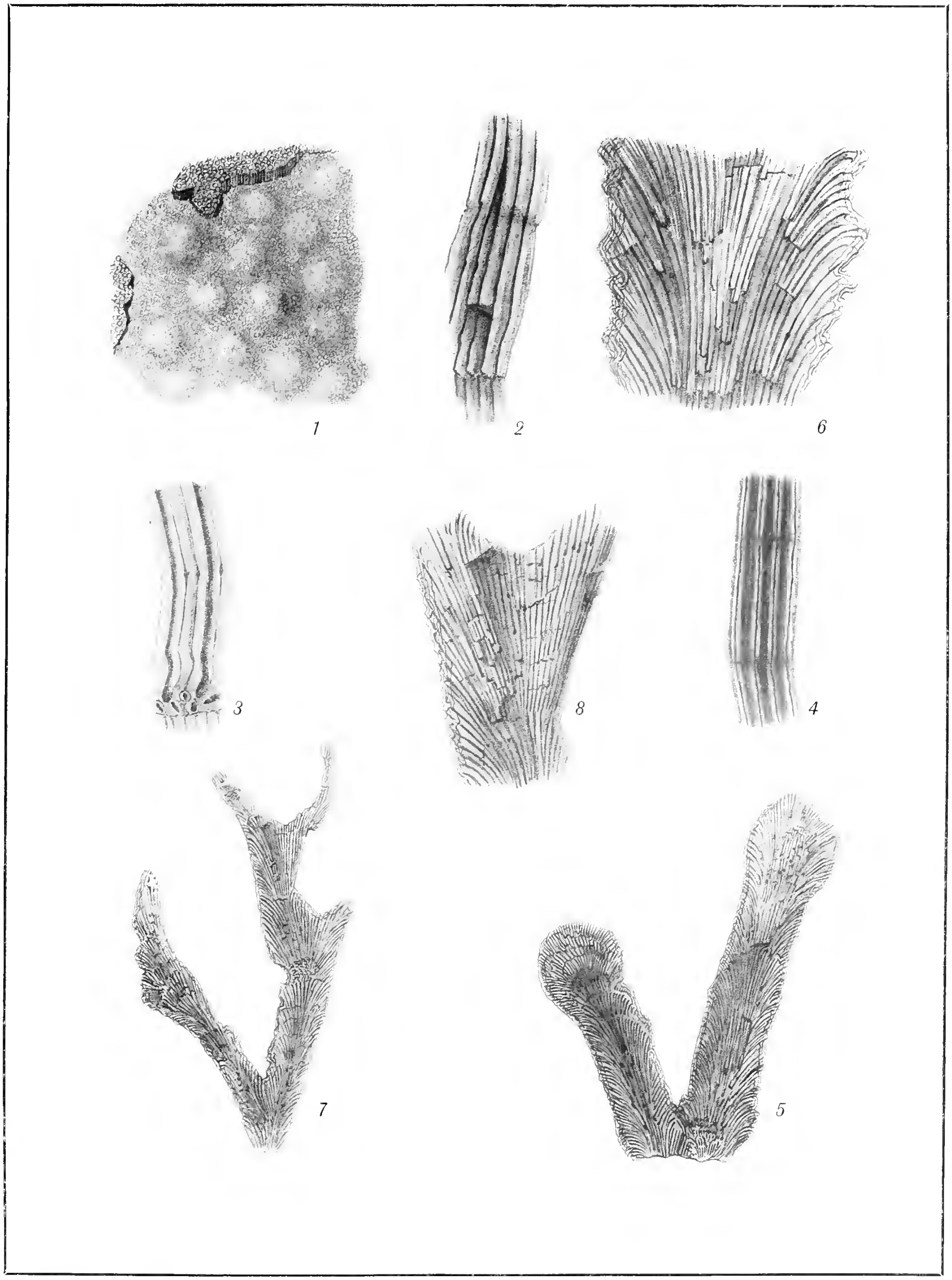
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PLATE VI.

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Trachypora Wilkinsoni, Eth. fil. 26

Fig. 1. Vertical microscopic section showing the dense secondary peripheral deposit, the axial filled-up corallites, with portions of their median lines left open, and crossed by tabulæ, x. 4.

Fig. 2. Similar horizontal section with the sclerenchyma of the axial corallites well marked, leaving in most cases a small central space; and the peripheral corallites gradually bending over to their more or less horizontal position, as evinced by their oblique section, with great thickening of their walls, x. 4.

Stenopora crinita, Lonsdale 49

Fig. 3. Horizontal microscopic section, exhibiting the polygonal corallites, with alternate light and dark concentric rings of secondary sclerenchyma, developed in a greater or less degree, x. 7.

Fig. 4. Similar section, exhibiting the primordial wall, lining of secondary deposit, and acanthopores at the corallite angles, x. 15.

Fig. 5. Another section, showing the fibro-concentric structure of the partially-thickened walls and the triangular young corallites at the calice angles, x. 50.

Fig. 6. Vertical microscopic section of a few tubes exhibiting a line of moniliform constrictions and the long expanse of simple tubes without tabulæ, x. 8, x. 8.

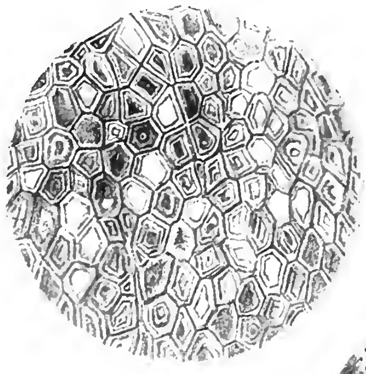
Stenopora ovata, Lonsdale 55

Fig. 7. Vertical peripheral microscopic section exhibiting tabulæ and the walls partially thickened, x. 9.

Fig. 8. Vertical microscopic section from immediately below the surface showing the peculiar form assumed by the moniliform swellings of this species, x. 12.

Figs. 1, 2, from Mulbring.
3, 7, 8, „ Singleton.
4, 5, 6, „ Wollongong.

N.B.—The enlargements are approximate.



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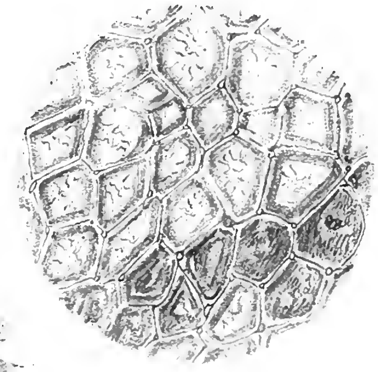

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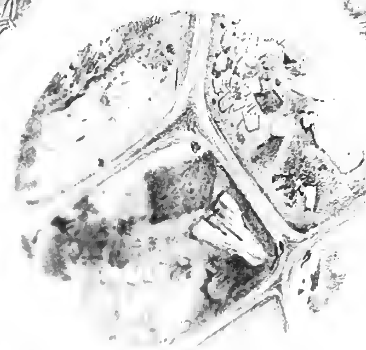

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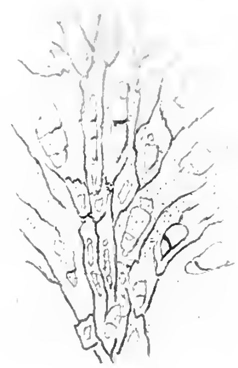

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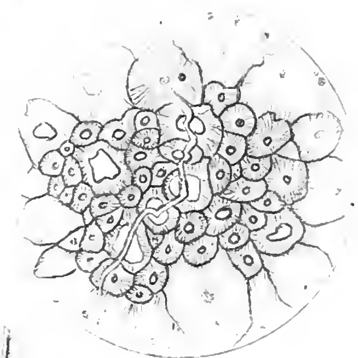

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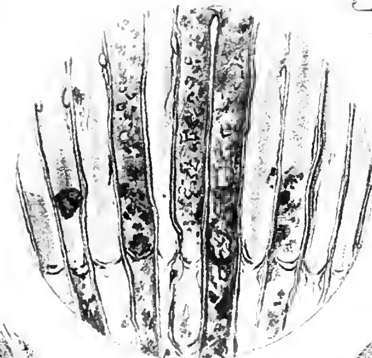

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PLATE VII.

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Stenopora crinita, Lonsdale 49

Fig. 1. Vertical peripheral section to show the elongated tear-shaped moniliform constrictions and tabulæ, x. 16.

Stenopora crinita, Lonsdale? 49

Fig. 2. Axial horizontal section, with thickened and unthickened primordial walls. Acanthopores highly developed, with the concentric structure of their walls apparent, and each with a central clear spot, x. 15.

Stenopora ovata, Lonsdale 55

Fig. 3. Horizontal section, with thickened and unthickened walls. In the former are visible the primordial wall, structure of the secondary thickening, and young corallites at certain angles of the calices, x. 20.

Fig. 4. Tangential section with the whole of the walls thickened; the acanthopores highly and irregularly developed, and the centre of each occupied by a dark spot; corallites very irregularly oval, x. 20.

Fig. 5. Longitudinal section of peripheral region to show the peculiarly crowded and exceedingly moniliform condition of the constrictions and their concentrically fibrous structure, x. 25.

Fig. 6. Longitudinal peripheral section in which the sclerenchyma has been dissolved from the monilæ, leaving them as hollow shells, x. 15. .

Frondescent *Stenopora* 59

Fig. 7. Tangential section, showing enormously-thickened walls and copious development of acanthopores, x. 15.

Stenopora Leichhardti, N. & E. 58

Fig. 8. Slightly oblique section of the peripheral region to show the tube-like character of the acanthopores and the generally-thickened walls, x 20.

Stenopora tasmaniensis, Lonsdale 60

Fig. 9. Vertical section partly axial, partly peripheral, showing monilæ, a tabulum, and the inner margin of the greatly-thickened periphery, x. 10.

Figs. 1 and 3 from Singleton.
2, 4–7 „ Tasmania.
8 „ Bowen River Coal-field, Queensland.
9 „ Jerringong.

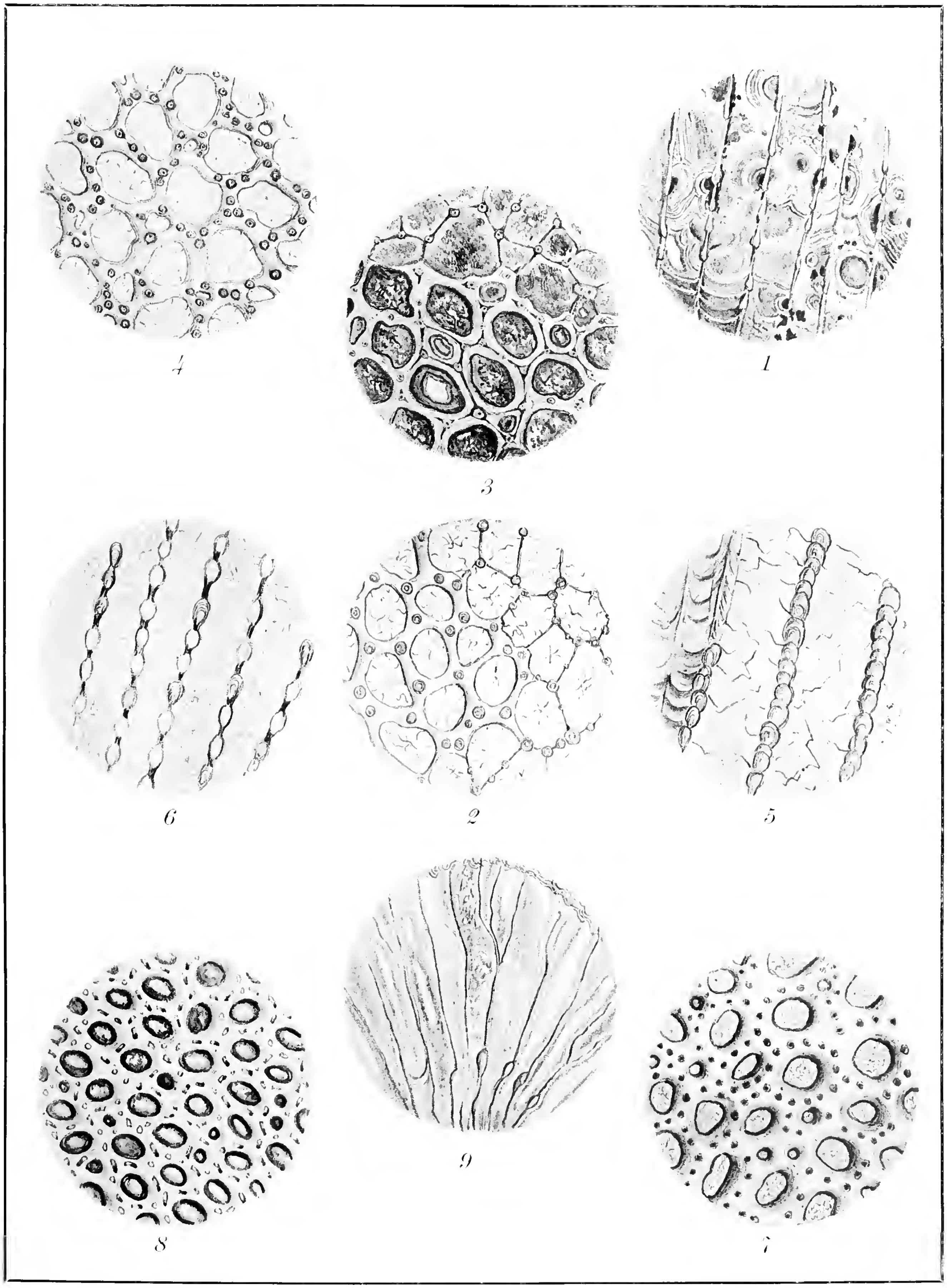
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PLATE VIII.

Fig. 1. Naturally-fractured section of the corallum, immediately below the calice, showing septa, fossula, and small tabulate area, x ½.

Fig. 2. Opposite end of the same specimen, at a depth of three-quarters of an inch, showing the under-surface of a tabula with the fossula and septa faintly marked at the margin, x ½.

Fig. 3. Corallum seen from the ventral side.

Fig. 4. ,, seen laterally.

Fig. 5. ,, of a more robust variety, seen laterally.

Fig. 6. ,, ,, ,, seen ventrally.

Fig. 7. Vertical section of a corallum, showing the base of the calice composed of large vesicles, and an upwardly-directed process of the floor.

Fig. 8. Naturally-fractured transverse section, with a large fossula and central tabulate area, x ½.

Fig. 9. Transverse section, showing septa, scattered dissepiments, and vesicular base of calice, x 2.

Fig. 10. Portions of five septa, highly enlarged, to show the flexuous primordial septum in each.

Fig. 11. Naturally-weathered calice, x ½.

Fig. 12. Naturally-weathered transverse section, in which the whole of the loculi have become filled with stereoplasma, x ½.

Fig. 13. A weathered corallum, side view.

Fig. 14. Calice and part of corallum, ventral view, showing septa and fossula, x ½.

Fig. 15. Transverse section, showing septa and vesicular base of calice, x 2.

Fig. 16. Vertical section, showing vesicular base of calice.

Figs. 1–16 from Shoalhaven District.

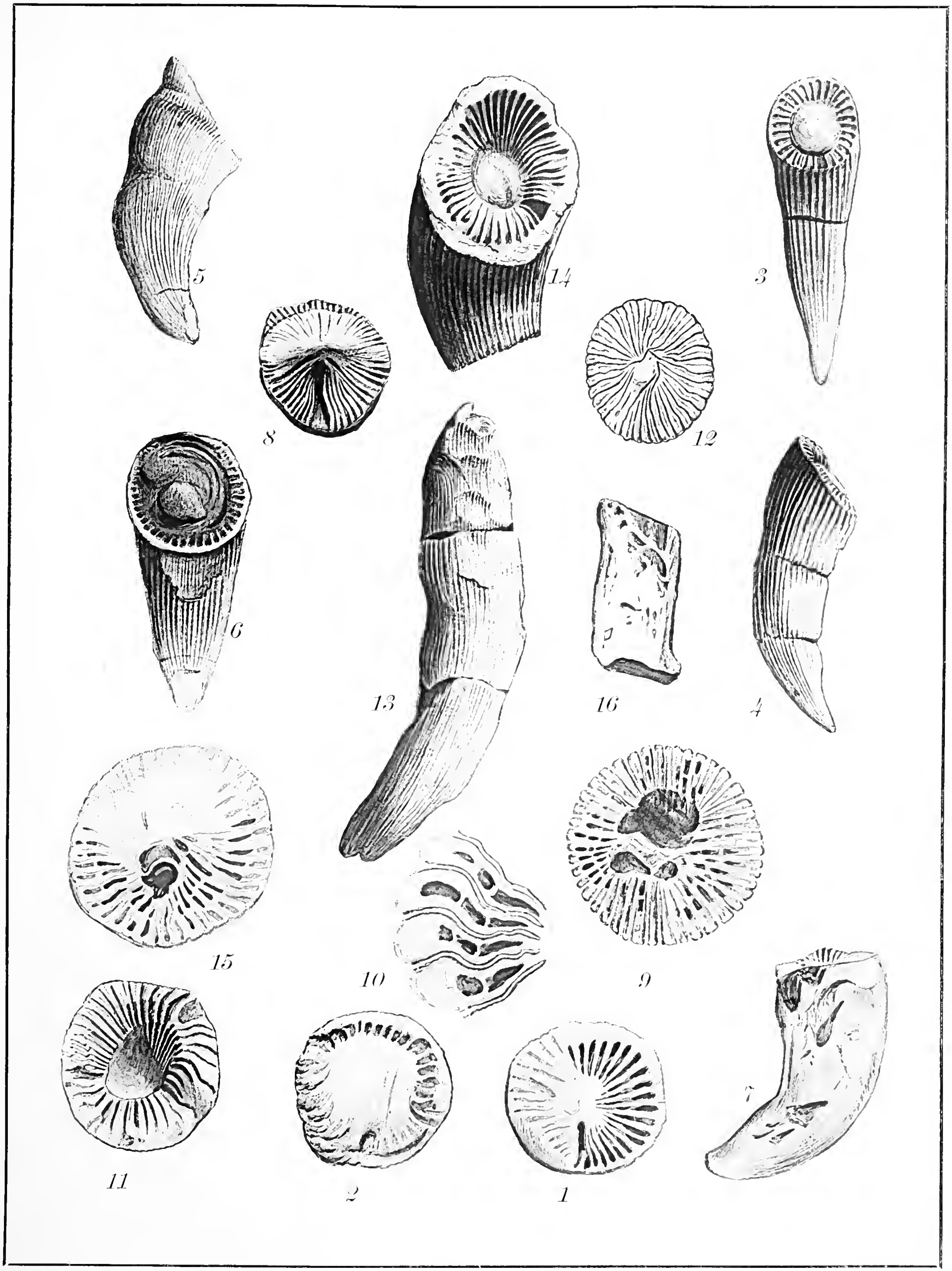

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PLATE IX.

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Zaphrentis Culleni, Eth. fil. 13

Fig. 1. A much-curved corallum, showing the slight accretion swellings, x ½.

Fig. 2. A less-curved corallum.

Fig. 3. A much-curved corallum, with constricted base and delicate rugæ, x ½.

Fig. 4. A small cornute example, but little curved, x 2.

Fig. 5. Transverse section below the calice entirely filled with stereoplasma, x 3.

Fig. 6. Another section in which the loculi are partly filled only, x 3.

Fig. 7. Section with the calice, with primary and secondary septa, x 3.

Zaphrentis gregoriana, De Koninck (?) 11

Fig. 8. An internal cast of a corallum with impressions of the epithecal spines on the adjoining matrix, x 2.

Fig. 9. Impression of the exterior of a corallum, with the imprints of the epithecal spines.

Amplexus, sp. ind.... 7

Fig. 10. Cast of a portion of a corallum, from which the whole of the calcareous matter has been removed, showing the position of tabulæ, x 2.

Zaphrentis, arundinaceus, Lonsdale, sp. 9

Fig. 11. Calice, naturally weathered, x ½.

Fig. 12. Lower fractured end of the same specimen at one and a quarter inches, to show similar characters to Pl. VIII, Fig. 2, x ½.

Fig. 13. A reversed corallum, to show the irregular vesicular tabulæ.

Zaphrentis phymatodes, Eth. fil. 15

Fig. 14. Side view of corallum, with obtuse tubercles.

Fig. 15. A few of the tubercles seen on Fig. 14 highly magnified. (N.B.—The stellate appearance is too highly intensified.)

Fig. 16. The upper part of the corallum, with the septa gathering towards the centre, and the loculi partially filled, x ½.

Fig. 17. The lower portion of the same, with the loculi further filled with stereoplasma, x ½.

Campophyllum columnare, Eth. fil. ... ...

Fig. 18. Corallum, side view.

Fig. 19. Transverse section, showing tabulæ, dissepiments, and central tabulate area, with rather vesicular tabulæ, x ½.

Fig. 20. Transverse section, with a large tabulate area, x ½.

Figs. 1– 7, 18–20, from Binge Berry, Rouchel Brook.
8–13, „ Shoalhaven District.
14–17, „ Mulbring.

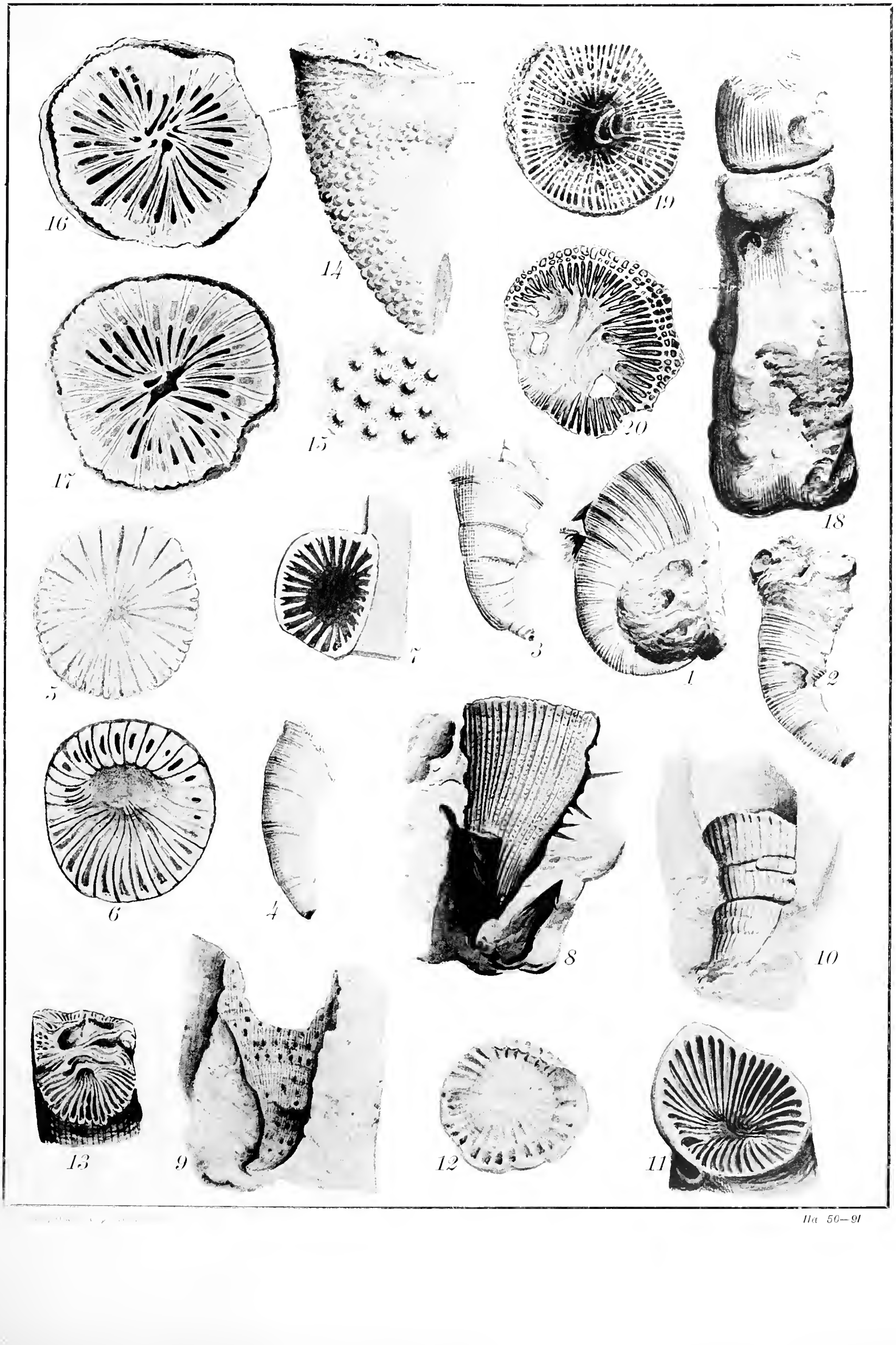
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PLATE X.

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Zaphrentis robusta, De Koninck 14

Fig. 1. An almost complete corallum seen from the side, x $\frac{1}{2}$.

Fig. 2. Base of Fig. 1, showing cardinal, counter, and alar septa, x 2.

Fig. 3. Calice margin with septa, x $\frac{1}{3}$.

Cyathophyllum? zaphrentoides, Eth. fil. 21

Fig. 4. Parent corallum, side view, with a young corallite springing from the calice.

Fig. 5. Transverse section of the lower part of the corallum, x $\frac{1}{2}$.

Fig. 6. Transverse section of the upper half of the same, x $\frac{1}{2}$.

Lophophyllum corniculum, De Koninck 18

Fig. 7. Corallum, side view, x $\frac{1}{2}$.

Fig. 8. Transverse section of the calice towards its base, with septa, a few dissepiments, and the spurious columella, x 2.

Fig. 9. Similar section taken at a lower level, x 2.

Aulophyllum Davidis, Eth. fil., *Var.* 23

Fig. 10. Corallum, side view, showing irregular growth.

Fig. 11. Portion of a vertical section, with the three subdivisions of the corallum—outer, or interseptal space; intermediate, or interlocular space; and interlamellar, or central area, x $\frac{1}{2}$.

Fig. 12. Transverse section with similar features, x $\frac{1}{2}$.

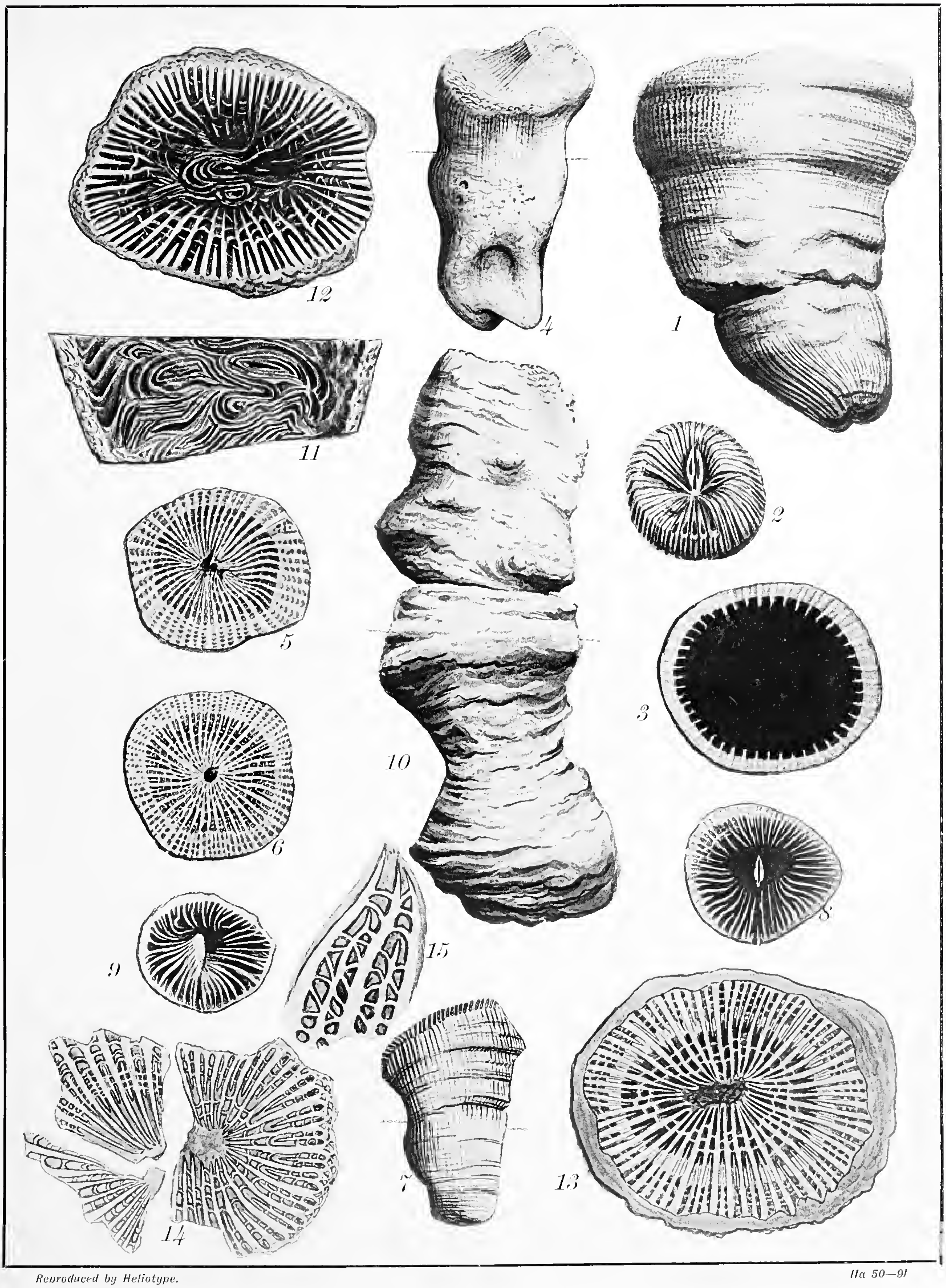
Cyathophyllum retiforme, Eth. fil. 22

Fig. 13. Transverse section below the calice, x $\frac{1}{3}$.

Fig. 14. " " at a rather higher level, x $\frac{1}{3}$.

Fig. 15. A few septa, highly enlarged, to show the peculiar dissepiments between the primary and secondary septa.

Figs. 1–3, from Branxton.
4–6, 10–15, " Binge Berry, Rouchel Brook.
7–9, " Dungog Road.



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Ha 50—91

PLATE XI.

Page.

Aulophyllum Davidis, Eth. fil. 23

Fig. 1. Corallum, side view.

Fig. 2. Transverse section, showing the three areas of subdivision, x ½.

Fig. 3. Portion of longitudinal or vertical section.

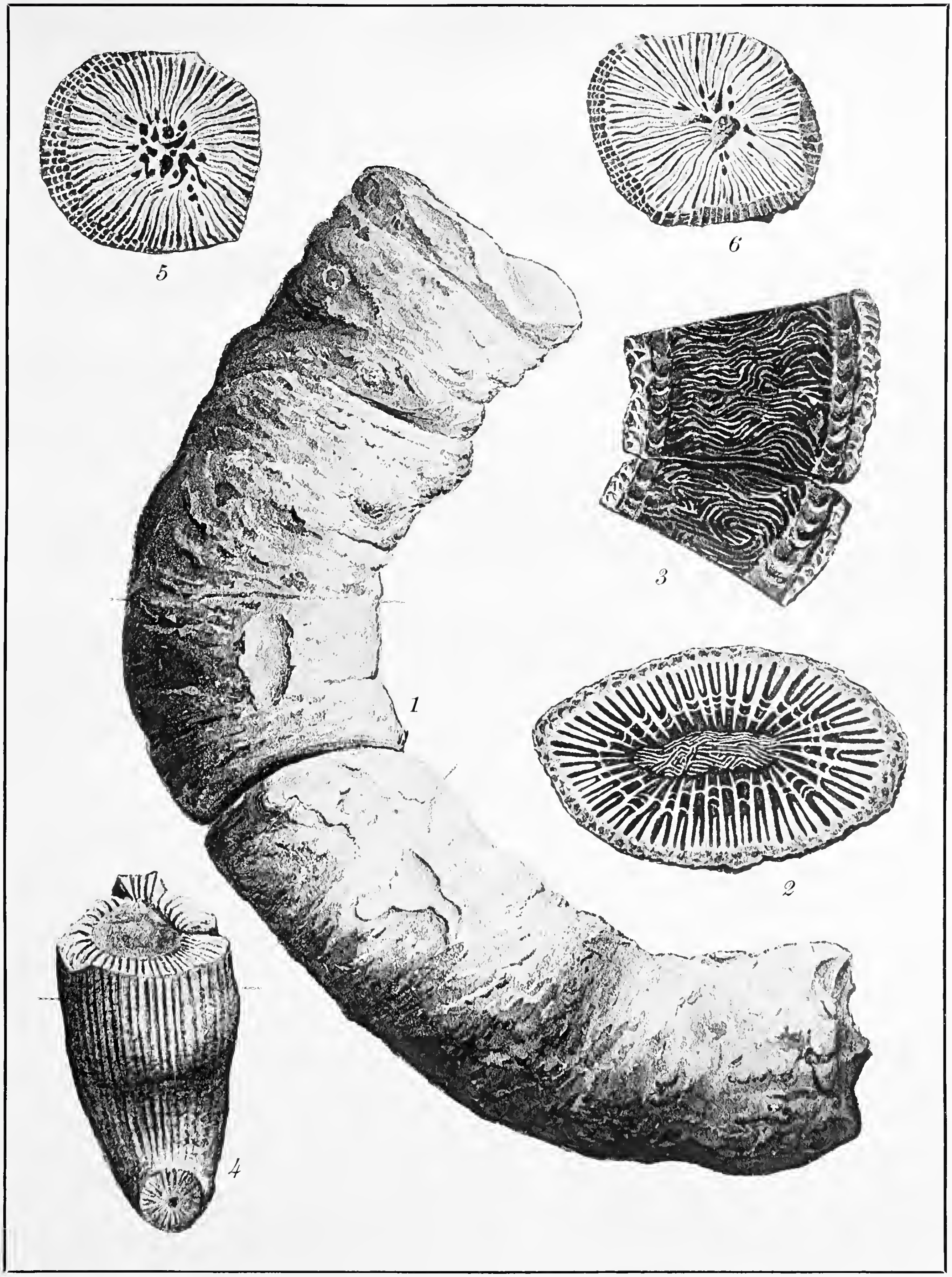
Zaphrentis ? sumphuens, Eth. fil. 16

Fig. 4. Corallum, ventral view, x ½.

Fig. 5. Transverse section immediately below the calice, x 2.

Fig. 6. Transverse section at a lower level still, x 2.

Figs. 1–3, from Binge Berry, Rouchel Brook.
4–6, ,, Somerton.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