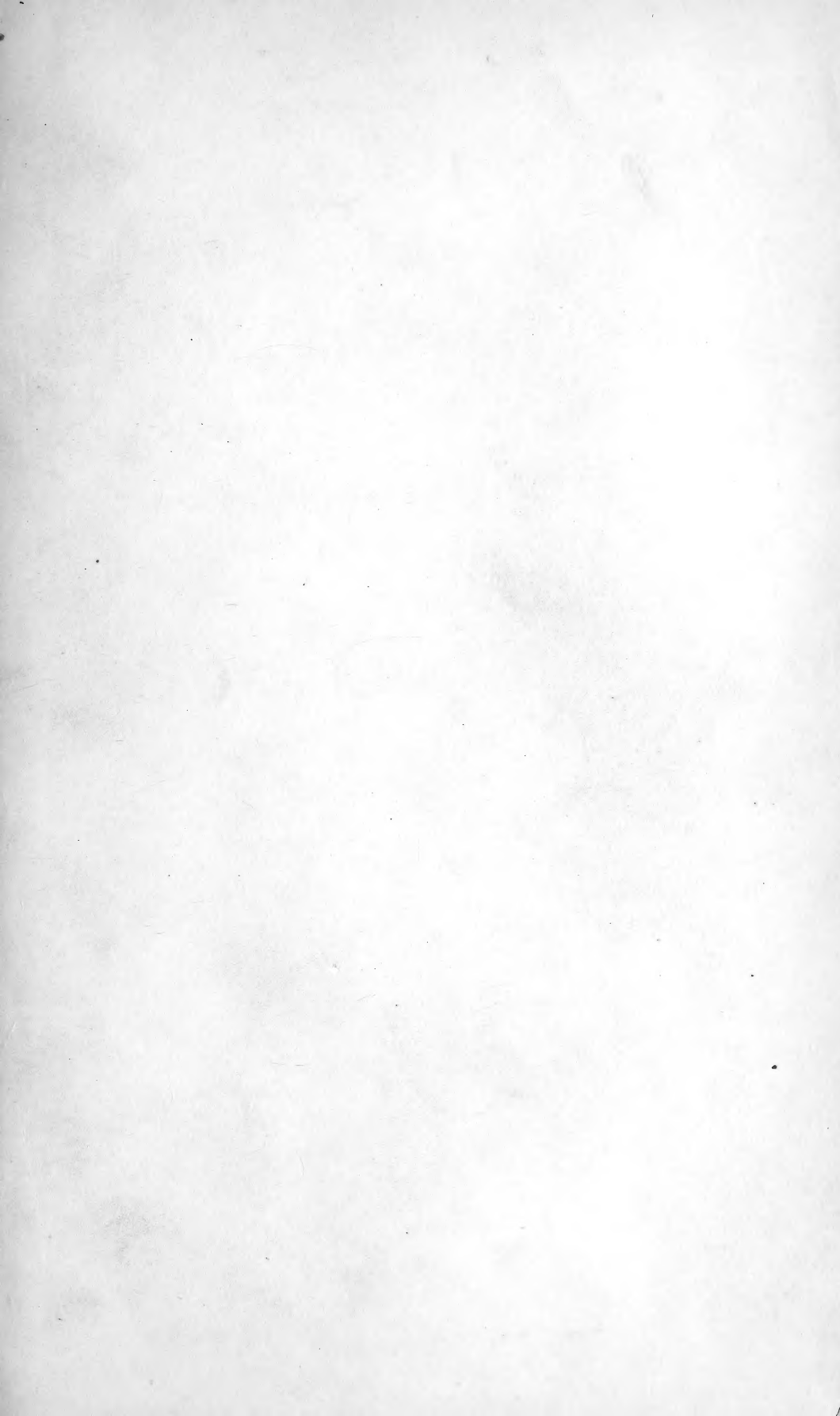
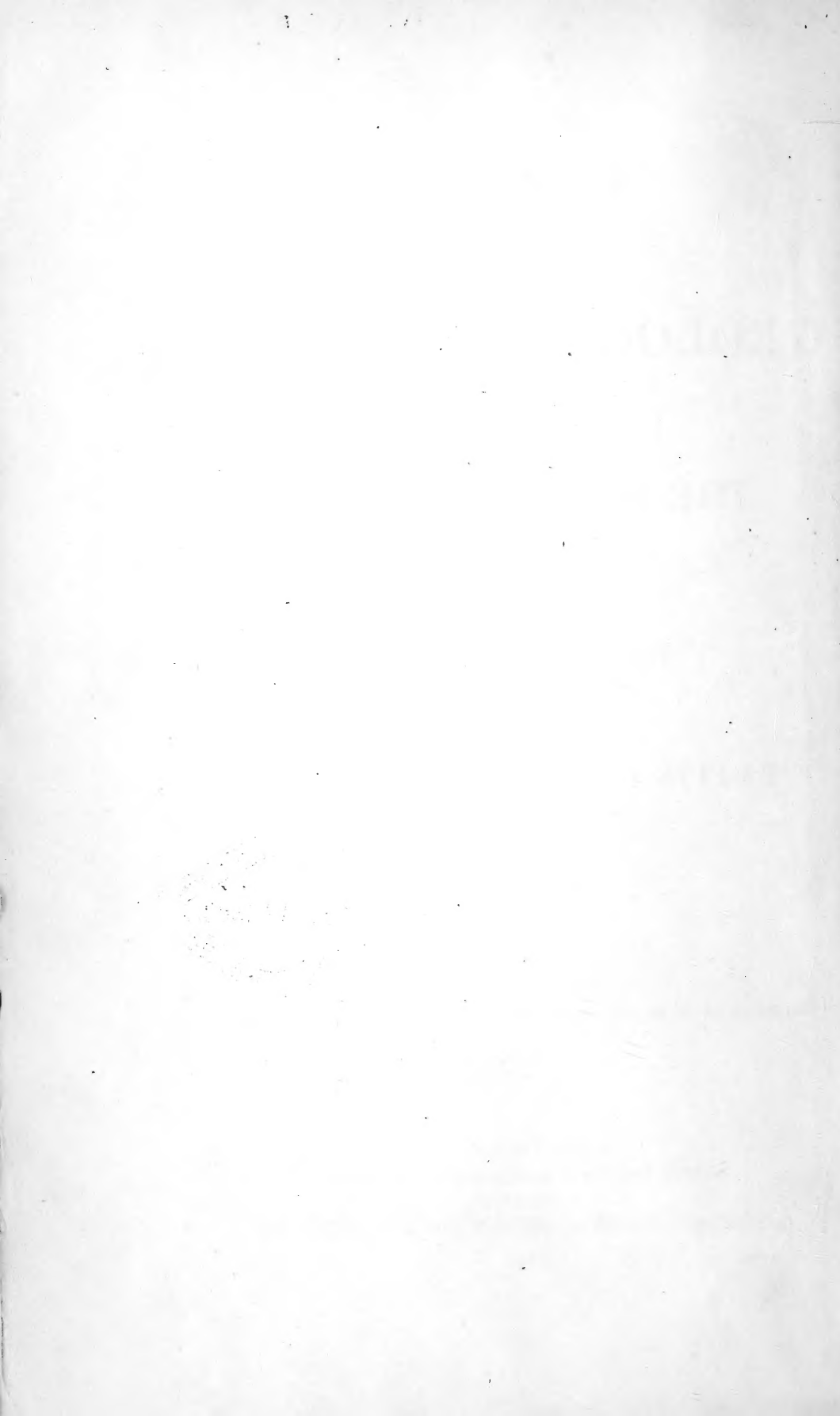


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GEOLOGICAL SURVEY

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*Figures and Descriptions*

ILLUSTRATIVE OF

### BRITISH ORGANIC REMAINS.

DECADE VII. ~~XI~~



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BRITISH FOSSILS.

DECADE THE SEVENTH.

THIS Decade is devoted to figures and descriptions of Trilobites, a group of extinct Crustacea of the highest geological interest. These remarkable fossils are wholly restricted to Palæozoic formations. The progress of research has shown that the various genera and species of Trilobites are remarkably characteristic of well-defined geological horizons; consequently, the study and exact definition of them is laid much stress upon by the geologist whose labours are directed to the investigation of the more ancient rocks.

The recent publication of a beautiful work by M. Barrande, on the Trilobites of Bohemia, in which the species are fully illustrated and described, affords means of comparison with the specimens of British Trilobites (usually less perfectly preserved), such as we did not before possess. It will be seen from the following descriptions that but few of our species are identical with those of Bohemia, and thus we get at an interesting indication of a geographical distribution of these primæval animals.

Of forty-five species here described, but one, a *Phacops*,—a member of a different section from that previously illustrated, belongs to any genus as yet selected for these Decades.

Cheirurus is exemplified by a species heretofore known only in a fragmentary state.

Sphærexochus mirus is a cosmopolitan fossil, of which excellent specimens have been lent to us for illustration.

Encrinurus and *Acidaspis* are typified by new species from the lowest fossiliferous deposits.

BRITISH FOSSILS.

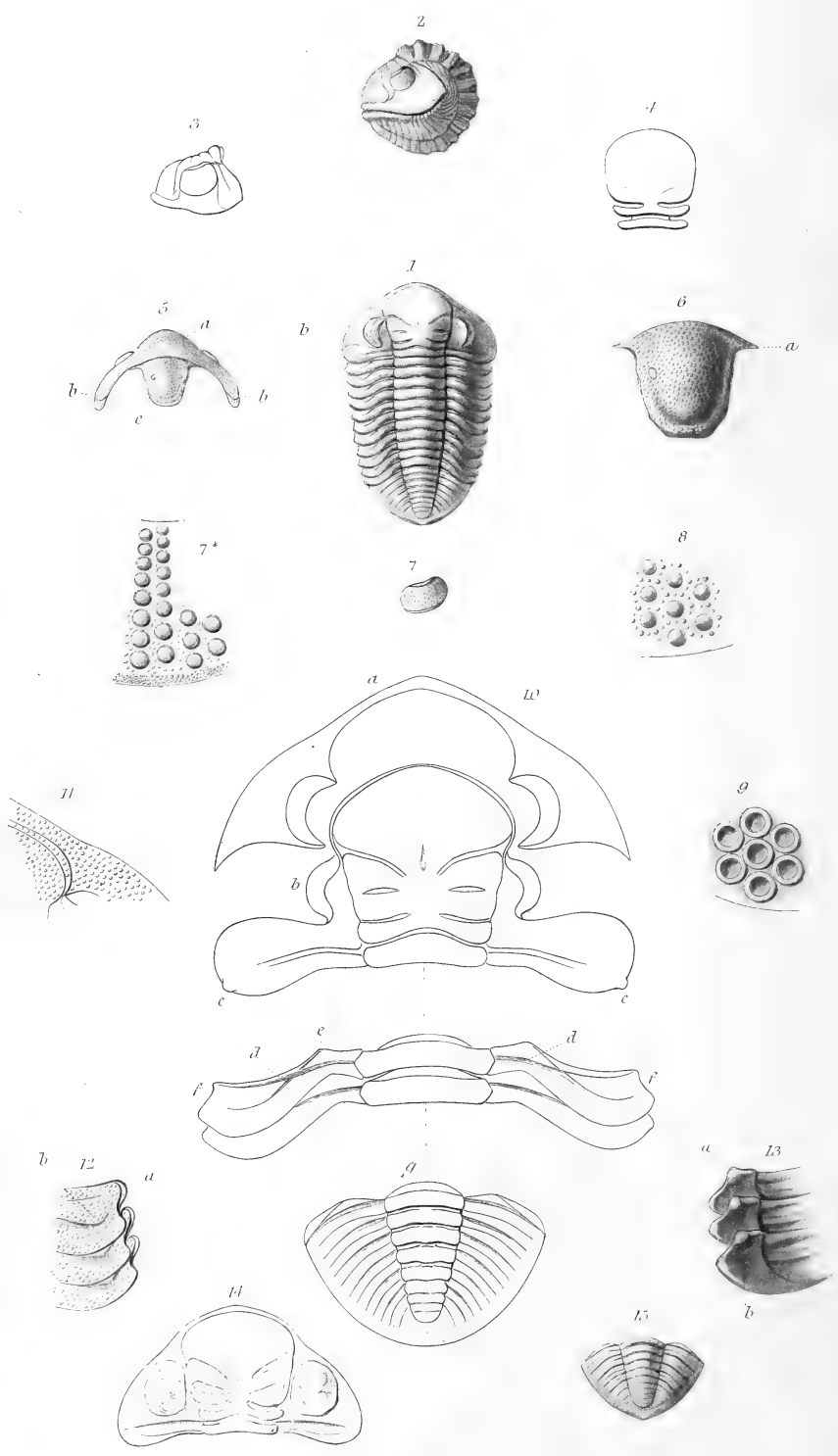
Cyphaspis and *Æglina* are for the first time published in England; and a new genus, *Cyphoniscus*, is proposed for some minute and hitherto undescribed forms.

Remopleurides is republished, with some additional data for the correct account of its structure. It is proposed, for what appear to be cogent reasons, to refer some curious variations in closely allied forms to sexual differences.

Under the ten genera here illustrated, the descriptions of all known British species are given. They have in every instance been drawn up by Mr. Salter.

EDWARD FORBES.

August 1, 1853.



PHACOPS DOWNINGIÆ — Murchison.

BRITISH FOSSILS.

DECADE VII. PLATE I.

PHACOPS DOWNINGIÆ.

[Genus PHACOPS. EMMRICH. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadæ.) Head strongly trilobed; glabella lobed, and broadest in front; facial suture ending on the external margin; eyes largely faceted; hypostome oblong, rounded at the end; thorax of 11 segments, the pleuræ grooved and faceted for rolling up; tail strongly ribbed, of several segments, the margin entire or toothed.]

[Sub-genus *Acaste*. GOLDFUSS. Form convex, and contractile into a ball. Glabella not much inflated, all the lobes distinct; facial suture within the edge or marginal in front; head angles rounded or with short spines; hypostome obtuse, entire; body segments rounded at the ends; tail of a moderate number of distinct segments (11 or less), its edge without lateral spines.]

DIAGNOSIS. *P. alutaceus*; *capite transverso, margini frontali angulato*; *glabellâ depressâ oblongâ subparallelâ, sulcis utrinque tribus distinctis, lobo basali lineari, secundo ovali, superiori transverso—sed margine superiore ascendente sinuato—lobis omnibus planis et fere ad medium glabellæ extensis, spatio angusto interjecto: lobo cervicali elevato; oculis magnis nec eminentibus: caudâ subtrigonâ, axi convexo costis quinque distinctis tribusque obscuris prædito,—lateribus quinque-costatis, costis duplicatis; margine distincto, apice angulato.*

SYNONYMS. *Calymene macrophthalma* (BRONGN.), BUCKLAND (1836), Bridgw. Treatise, pl. 46. fig. 5 (not 4.) *Calym. ? Downingiæ*, MURCHISON, Silur. Syst. (1839), pl. 14. fig. 3. MILNE EDWARDS (1840), Crust., 3. 324. *Acaste Downingiæ*, GOLDFUSS, Syst. Uebersicht der Tril., Neues Jahrb. (1843), 563. *Phacops macrophthalmus*, BURMEIST. (1843), Org. der Tril., 139, 140, and in ed. 2. (1846), p. 92. *Phacops Downingiæ*, EMMRICH, Neues Jahrb. (1845), 40. pl. 1. fig. 2. [icon mala]; Transl. in Taylor's Scient. Memoirs (1845), vol. iv. pl. 4. fig. 2. PHILLIPS and SALTER, Memoirs Geol. Surv. (June 1848), vol. ii. pl. 1. p. 239, 336. pl. 5. fig. 2. 3. 4. M'COY (1851), Synopsis Pal. Foss. Woodw. Mus. 160.

Junior.—*Asaphus subcaudatus*, and *A. Cawdori*, MURCHISON, Sil. Syst. pl. 7. fig. 9, 10. *Phacops subcaudatus*, SALTER and PHILLIPS, l. c. 239.

One of the most common, and certainly one of the most elegant trilobites in the Silurian System—occurring in abundance wherever Upper Silurian strata are found. It is a very characteristic fossil of

the Dudley limestone. And yet, perhaps, there is no species of trilobite which has been so much misunderstood; the confusion apparently arising from this circumstance—that it is rarely, if ever, found out of Britain; although somewhat similar species have been identified with it, both British and foreign. It was named in compliment to Mrs. Downing, of Dudley, from whose cabinet the figures in the “Silurian System” were drawn.

Description.—Length from an inch and a half to two inches. The general form long-ovate, the anterior end being considerably broader, and with the axis following the same lines, and regularly tapering from head to tail. The surface is moderately convex, the axis raised above the sides, not separated by deep furrows except in the head, and more convex in the thorax than in the head or tail. The head is somewhat less than a semi-circle, though just twice as long as broad, the general outline being rather triangular, from an indentation in the curved outer margin on each side of the wide glabella; the front is not produced, but angular. The glabella occupies more than one third the width of the head in front, and tapers but little backwards, having nearly straight and parallel sides; it rises considerably above the cheeks, but is rather depressed than convex, especially the forehead lobe, which is not at all inflated, but slopes gradually to the narrow front margin, from which it is separated by a shallow furrow. Neck lobe strong, broader than the first basal lobes, which are transverse and linear; the middle pair are broader than these, and oval, the direction of the first and second furrows determining their shape—the lower furrow curves downwards, and reaches the side of the glabella; the upper one, which is abbreviated, curves the reverse way; the upper lateral lobe is transverse, scarcely triangular, and bounded above by a sigmoid furrow, which runs very obliquely out above the eye. All the furrows stretch equally towards the middle of the glabella, leaving but a narrow space between their ends; between the upper pair a short longitudinal depression occurs. The lobes are not swelled between the furrows, but the surface is even and the furrows shallow (they are, however, sharply defined on the internal cast); the neck furrow and basal furrows are strong—the two upper ones very faint.* The cheeks are steeply bent down, their outer margin not distinguished by any furrow, and they slope gradually from the eye, without any ridge or groove beneath the latter; the neck furrow is continued almost to the posterior angle, which is rounded off and only shows a slight projection (fig. 10, *c*) in the place of a spine. The facial

* Memoirs Geol. Survey, vol. ii. p. 1. pl. 5. fig. 2.

suture cuts the outer margin in a curved line in front of the posterior angles, and opposite the base of the eye; on the under surface of the head (fig. 5) the suture cuts the margin further backward (*b b*). Above the eye it continues along the axial furrow and round the front of the glabella just outside the marginal furrow. Eyes rather large, conical, rising in some specimens nearly to the level of the glabella, placed about half-way up the cheek, near to the two upper glabella lobes, and occupying their length: eye lobe with a raised outer margin; lentiferous surface broad, with about 155 lenses in each eye, each vertical row containing eight. The cornea is convex over the lenses, and the intermediate flattened spaces are finely granular, the granules forming a rough hexagonal network toward the base of the eye; the lenses are nearly their own diameter apart, but this varies much in different individuals, the space being often much less (figs. 7, 8).

On the under side of the head, the incurved front portion (which, as in all the genus, is continuous across,) is broad (fig. 5, *a*), and granular, like the upper surface; it supports the broad base of the hypostome, which is also granulated. This organ is subquadrate but broadest at its base, and very regularly convex, almost tumid; a faint concentric furrow running round the sides and tip just indicates a narrow margin, more flattened than the other parts; there are no lateral furrows, but high up on each side is a small tubercle. The tip is straight and somewhat truncate, and the exterior angles are cut off so as to render the end somewhat polygonal; but there are no traces of projecting teeth, and the appearance of the apex is obtuse. The entire organ is much narrower than the glabella, and not above half its length, but from the position of its base it reaches as far backward as the middle pair of glabellar furrows. And these glabellar furrows, as Burmeister has shown, doubtless indicating the position of the jaws and accessory parts of the mouth, the hypostome must have served the office of labrum or upper lip.

Thorax considerably longer than the head, of 11 not very highly arched rings—the axis moderately convex, of nearly equal breadth with the pleuræ. These, which are traversed by a straight deep groove, (fig. 10, *d*), are curved rather abruptly downwards at the fulcrum (fig. 10, *e*), which anteriorly occurs at the inner third of their length, and in the posterior ring does not reach further than one fourth. The anterior edge of each pleura is sharpened or faceted* to pass under the preceding one, and the posterior edge is thickened. Each pleura is much bent forward at its end, which is deeply notched

* M'Coy, Annals Nat. Hist. (Dec. 1849.)

(figs. 12, 13), and on the under side of each, in front of this notch, is placed a tubercle (fig. 13, *a*). When the animal was in the act of rolling up, the tubercle prevented the next ring from being pushed too far forward; the tail, too, has them on its anterior edge. Some such contrivance as this, for giving compactness to the rolled up form, is probably general in trilobites, and Mr. John Gray, of Dudley, who first drew my attention to it, has succeeded in developing nearly the whole of the under surface of this species.

The tubercles just mentioned occur on the incurved crustaceous portion (fig. 13, *b*) of the pleuræ, which, in this species is but narrow, while in *P. caudatus*, Decade II. Pl. 1., it extends some distance inwards.

The tail is sub-triangular and rather pointed, nearly twice as wide as long, and moderately convex; the axis is more convex, but does not rise abruptly from the general surface, nor is it separated from the sides by any distinct axial furrows. It is conical, not so wide as the sides, extending to about four fifths of the length of the tail, with an obtuse scarcely prominent end; it is crossed by five distinct and two or three obscure rings. The sides have five or six rather deep and curved furrows, which end abruptly at the thickened margin; smaller and shallower furrows occur between each of the principal ones for the whole length. The incurved under margin is narrow but thick.

The whole of the upper surface, and the incurved margins of the head and tail, are covered with fine, close, equal granulations; the hypostome is also equally rough—none of the grains become tubercles, but all remain of equal size.

Variations.—Among the specimens in the cabinets of Messrs. Fletcher and Gray, occur one or two with the eyes (fig. 3) very considerably larger than usual, so as almost to equal those of *P. Stokesii*; the specimens, however, clearly belong to the species we are describing. The following measurements in lines will give an idea of this difference, which is represented in our figure 3:

| <i>Ordinary specimen</i> :— | <i>Large-eyed variety</i> :— |
|-----------------------------|--|
| Length of head - - 5 lines. | Length of head - - $5\frac{1}{4}$ lines. |
| Length of the eye - - 2 „ | Length of the eye - - $2\frac{3}{4}$ „ |
| Height of eye - - 1 „ | Height of eye - - $1\frac{1}{2}$ „ |

The surface, therefore, in one case is nearly double that of the other, and the number of lenses is increased to about 180, the lenses themselves being each a little larger and not distant from one another more than half their diameter. Another specimen, in

Mr. Gray's cabinet (fig. 8.) has the lenses decidedly small, distant their full diameter from each other, and the intermediate granulations more elevated and connected into zigzag lines. Fig. 7* shows the ordinary surface of the eye. Some specimens have the axis of the body more prominent than others, and the tail is more pointed in some than in others. The glabella varies in width, and divergence of the axial furrows; many specimens having the sides nearly parallel, as in fig. 4, others, as fig. 10, somewhat more clavate. And in a dwarf variety from the Caradoc sandstone, found by Professor Sedgwick at Llanrwst, in North Wales, the clavate form is very marked. Occasionally (fig. 4) the two front furrows become quite obscure; but this is a rare variation. These two upper furrows are always shallower than the lower one and neck furrow, and they show but little in the internal cast; but they are never quite lost. Fig. 14 is from a fine large head from Ledbury, in Mr. C. Stokes's cabinet; the glabella furrows are remarkably deep, considering it is an internal cast, and the lobes somewhat more tumid than usual.

Affinities.—The variation just noticed gives the specimen a great resemblance to a nearly allied species, which, however, belongs to the section *Phacops*, viz.—*P. Stokesii*, M. Edwards, (*P. macrophthalma*, Brongn., t. 1. f. 5., figured in Mem. Geol. Surv., vol. ii. pt. 1. pl. 5. fig. 1). This, which is abundant at Walsall and Dudley, and frequently met with in the Wenlock limestones of the Malverns, is easily distinguished from all the varieties of *P. Downingia* by the shape of the lowest glabella lobe, which in this is narrow, very strongly marked off from the rest of the glabella by a nearly continuous transverse furrow, and its extremities are terminated by two rather small but strongly marked tubercles, while in *P. Downingia* this lobe is always linear and destitute of tubercles. The uppermost glabellar furrow is bent as if broken, while in *P. Downingia* it is a simple sigmoid curve. The tail of *P. Stokesii* has only two or three of the upper furrows of the axis and sides distinct; *P. Downingia* has them all marked, and the side furrows interlined by finer ones. But there is a Lower Silurian species, hereafter noticed, still more nearly resembling ours in all its parts—the *P. apiculatus*, Salter. In this the general shape of the head, and of the glabella and its lobes, have just the same appearance as those of our species, but a careful comparison will show marks of decided difference in all these parts. In the *P. apiculatus*, which is as common in the Lower as the *P. Downingia* in the Upper Silurian, the head is longer, and the glabella more elongate and narrower, and more con-

vex anteriorly ; from its greater length, too, the lobes do not appear so crowded ; they differ also in shape. The lower or basal pair are not linear and transverse, but subtriangular, and are cut off by a shallow depression from the body of the glabella (as in the sub-genus *Phacops*), and the neck lobe rises in the middle between them. The second or middle furrow extends to the glabella edge, and is bent down there ; and the upper one is more deeply impressed, and ends in a decided notch at the glabella margin, (even of this there is some trace in our species, but not nearly so distinct). There is an important difference, too, in the presence of a small spine at each of the head angles. The tail in *P. apiculatus* is decidedly triangular, and at the apex pinched up and drawn out into a recurved spine.

With *P. macrophthalma*, Brongn., t. 1. fig. 4., it really has little in common. The head of that species* is far too long in proportion to the breadth for *P. Downingia* ; the forehead lobe is too clavate, and the head long, not transverse, and with a strongly pointed front, as represented in the original figure. The eyes, cheek angles, glabellar furrows, and tail all differ widely from those of the species before us. From *P. Brongniarti*, considered the same with it by Col. Portlock, it differs considerably. In that species, independently of the great length of the head, the glabella is widely clavate, with its basal pair of lobes obsolete, and the eyes enormous ; the furrows also of the tail are almost twice as numerous. It appears to be the pointed form of the head, not, however, very conspicuous in *P. Downingia*, which has suggested the reference of this and of other trilobites to our species. *P. microps* (Green), as far as can be ascertained from his cast, No. 6, much resembles *P. Downingia*, but it cannot be identified. *P. Phillipsi*, Barrande, is very like our species, but the glabella furrows do not converge, and the upper ones are nearly obsolete.

History.—Had Brongniart not figured two trilobites with large faceted eyes under one common name, thereby implying that they were at least closely related, it is not probable that any succeeding author would have identified the species we are describing with either of his figures. But as one of these was from an original drawing, made for Mr. Stokes from a Dudley specimen, it was

* M. Ad. Brongniart's kindness permitted us to examine the original figured specimen at the Jardin des Plantes in 1849. Of four specimens arranged as *P. macrophthalma* in this collection, the figured specimen is the only one without the name attached. One, particularly labelled by Alex. Brongniart as *P. macrophthalma*, has a more clavate glabella than the true species, and is a decided *Cryphæus*, from the United States.

likely that both British and foreign naturalists should conceive the common Dudley species, with a pointed front, to represent the more pointed variety of Brongniart. Green, in his description of the *C. macrophthalma*, 1832, noticed the great difference between the two figures: and, referring to a fine slab of Dudley trilobites, noted that these agreed exactly with the description given by M. Brongniart of the head of his species; and one of Green's published casts is from a British specimen.

Professor Buckland, who in 1836 published a drawing of this species in the Bridgewater Treatise, conceived it to be represented by the more pointed form of *P. macrophthalma*, (Brongniart, fig. 4), and named it accordingly; and Sir R. I. Murchison followed this view, at the same time rightly distinguishing it from the obtuse headed species (fig. 5 of Brongniart), which occurs, though rarely, in company with it at Dudley. He considered the latter fossil, which has enormous eyes, to be more properly the type of Brongniart's species; and gave the new name to that one which was conceived to represent his figure 4. Milne Edwards in 1840 recorded it as distinct from either of Brongniart's species; and as the French fossil with a pointed front evidently furnished Brongniart with his description, retained his name, *Calym. macrophthalma*, for that species, and gave that of *C. Downingia* to the present one. He also applied a new name, *C. Stokesii*, to the rarer British fossil represented by Brongniart's fig. 5. In this view all naturalists are now agreed. In the meantime, and immediately after the publication of the Silurian System, Professor Emmrich had established the very natural genus *Phacops* for all those trilobites with largely faceted eyes and 11 segments to the thorax; and he of course quoted the present species under the genus, but supposed it might probably be a variety of his Bohemian species, *P. proævus*. He afterwards, 1845, admitted it under the present name. Professor Goldfuss, too, in the general systematic Review of Trilobites, published in the Neues Jahrbuch for 1843, had admitted the species; and perceiving the great distinction that existed between those forms with all the glabella furrows distinct and strong, and those in which the anterior ones were obsolete, he separated the group which includes the present species under the term *Acaste*, reserving *Phacops* for those species with inflated heads and obscure glabella furrows, which Dr. Emmrich had already pointed out in his Dissertation as the type of his genus. The latter, in his systematic table of the genera, published in the Neues Jahrbuch for 1845, objected to this arrangement, and grouped together the two sections just adverted to as constituting

a sub-genus *Phacops*, while he formed the section *Dalmannia* for the more expanded forms, such as *P. caudatus*, *P. Hausmanni*, &c.*

Professor Burmeister had already, 1843, regarded our species as a synonym of *P. macrophthalma*, Brongn., and has repeated this reference in his second edition, 1846. And Lieut.-Col. Portlock, in his admirable work on the Geology of Tyrone, endeavoured to escape from the difficulty by proposing a fresh name, *P. Brongniarti*, to include Brongniart's and Murchison's species, as well as a new and perfectly distinct form, discovered by himself; thus adding innocently to the confusion. In the Mem. Geol. Survey, 1848, I returned to Milne Edwards' correct classification of these species, and described both the English forms. Professor M'Coy has since confirmed their distinctness, and we may now consider *P. Downingia* as having established its claim to rank as a distinct British species, highly characteristic of the Upper Silurian rocks, and unknown, so far as we are able to learn, in other countries.

British Localities and Geological Position.—CARADOC SANDSTONE to LUDLOW ROCK.—Caradoc Sandstone; Moel Seisiog, and other places near Conway and Llanrwst, North Wales (dwarf specimens). Wenlock Shale; Bryn Craig, &c., Usk; and Slate Mill, Hasguard, in South Wales. Wenlock Limestone; west of Hereford Beacon; Ledbury; Malvern Hills; Dudley and Walsall, abundant. Lower Ludlow and Upper Ludlow Rocks of the Abberley Hills. Upper Ludlow; Underbarrow and Benson Knot, Kendal; Pont-ary-Llechau, near Llangadoc, South Wales; Ludlow Rocks, Golden Grove, and other places south of Llandeilo.

EXPLANATION OF PLATE I.

- Fig. 1. *Phacops Downingia*, of ordinary size; Dudley limestone. (Collection of John Gray, Esq.) At *b*, the outer termination of the facial suture is seen.
- Fig. 2. Do.; a rolled-up specimen, same locality. (Collection of T. W. Fletcher, Esq.)
- Fig. 3. Do.; variety with very large eyes, each with about 180 lenses. Same locality and collection.
-

* As we think, however, that there are three distinct groups, we have adopted the term *Acaste* for the present sub-genus, and left the species with inflated and lobeless glabella in the section *Phacops*. In this latter view we have the sanction of the greatest authority on trilobites, M. de Barrande, whose great work, just received from the publisher, will long be the standard for reference. Otherwise we should have been unwilling to disturb the nomenclature adopted by Professor M'Coy, who has given to the latter group the new name *Portlockia*, reserving *Phacops* for those species which have the glabella lobes distinct, but have not the expanded form or numerous tail segments of *Dalmannia*.

- Fig. 4. Glabella of a specimen from the Wenlock limestones of the Malverns, with the two upper furrows nearly obsolete; the lower ones are stonger than usual; a rare variation. (Coll. Mus. Pract. Geol.)
- Fig. 5. Under side of the head, showing the entire rostral portion *a*, the termination of the facial suture on each outer side at *bb*, much further backward than on the upper surface (see fig. 1, *b*); *c*, the obtuse hypostome or labrum. (Coll. Mr. John Gray, Dudley.)
- Fig. 6. Hypostome of last specimen, magnified. The basal processes (*a*) extend even further outwards in some specimens, and are probably attached beneath to the ends of the upper glabella furrows.
- Fig. 7. Eye of an ordinary specimen, natural size. Dudley.
- Fig. 7*. Portion of do., highly magnified, showing the separate convex portions of the cornea over each lens, with granules on the interspaces.
- Fig. 8. Portion of the eye of another variety, with the lenses proportionally smaller and more distant, and the granules collected into an hexagonal network between them. Dudley.
- Fig. 9. Highly magnified cast, in fine silty mud, of the interior of the eye, showing the cups from which the lenses have fallen out. These cups therefore occupy the place of the depressed tip of the crystalline or vitreous body. (Burmeister.)
- Fig. 10. Enlarged specimen, the head divided at the facial suture, showing the first segment, *a*, as an entire ring or segment which bears the eyes. On the second ring, *b* is the upper eye lobe; *c*, the tubercle or rudimentary spine; at *d*, the pleural furrow is shown, and at *e*, the fulcral point of a middle thorax joint; *ff*, the notched tips of the pleuræ; *g*, the tail.
- Fig. 11. Part of the front of the head and glabella, to show the equal granulation of the surface.
- Fig. 12. Magnified notched ends of the pleuræ (upper side), showing their surface to be granulated even over the faceted portion, *b*; at *a* the tubercle is shown, which is better seen in the next figure.
- Fig. 13. Magnified under side of three pleuræ, showing the narrow incurved under portion *b*, and the tubercles which serve as buttresses in rolling up, *a*.
- Fig. 14. Internal cast of a large head, from Ledbury, Wenlock limestone (Mr. C. Stokes's cabinet); the furrows are much broader and deeper than usual.
- Fig. 15. Tail, natural size, from Dudley, to show the sub-triangular pointed form usual in the species.

Other British Species of Phacops, of the Section ACASTE.

1. *P. apiculatus*, Salter (1852), in Prof. Sedgwick's Synops. Classific. Palæozoic Rocks, fasc. 2, Appendix, iii. pl. 1 G. f. 17-19. *Portlockia?* *apic.* McCoy (1851), ib. fasc. 1. p. 162.

P. omnino P. Downingia similimus; sed capite longiore, glabellâ elongatâ, antice convexiore, lobis basalibus circumscriptis subtriangulatis nec transversis; sulco medio glabellari longiore, supremo distinctiore; oculis elongatis subdepressis; angulis posticis capitis brevissime mucronatis; caudâ ad apicem paullo compressâ et in apiculum recurvum brevem productâ; axi angustato.

Localities.—Common in the Llandeilo flags of North Wales, and in the Caradoc sandstone of Hope Bowdler and Acton Scott, Shropshire. [Geol. Surv. and Woodw. Mus.]

Heads of this species have also occurred in the hard quartzites of the coast of Cornwall, at the Great Peraver, in company with *Calymene*, *Orthis* and other Silurian forms.

2. *Phacops Brongniarti*, Portlock (1843), Geol. Rep. Tyrone, pl. 2. fig. 8. (excl. ref.) *P. Murchisonii*, ib. fig. 9.

P. biuncialis, *elongatus granulatus*, modice convexus; capite longo trigono, fronte angulato subrecurso; glabellâ ad basin contractâ antèrèus valde dilatâtâ nec convexâ, lobis utrinqùe tribus radiantibus; lobo antico maximo triangulato, a frontali sulco valido—a medio sulco leviore—sejuncto; lobis infimis minutis hemisphæricis circumscriptis sese remotis; lobo verticali eminentiore; oculis maximis, a lobo frontali usque ad sulcum verticalem tractis; angulis genarum obtusis; thorace axi convexo angustato, lateribus parallelis abruptè deflexis; pleurarum apicibus rotundatis, fulcro intra medium posito; caudâ trigonâ, axi longe conico angustissimo fere ad finem caudæ extenso, decies annulato; apice prominulo; lateribus 5-costatis, costis per totum divisis, nec marginem lævem attingentibus.

Col. Portlock had united with this species both the *P. macrophthalma* of Brongniart, and *P. Downingia*, Murch. They are however, as above stated, quite distinct species. The present is well characterized by the pointed front and contracted base of the glabella, as well as by the large eyes, which have each 170 lenses.

Localities.—Bala and Llandeilo Rocks: Tyrone; Carrickadaggan, Wexford; Llanfyllin, and other places, N. Wales.

3. *P. Dalmanni*, Portl. l. c. f. 7.

Omnino precedenti simillimus—caudâ multi-annulatâ, oculis maximis, glabellâ ad basin contractâ, granulosa; sed capitis fronte rotundato, nec producto; [an forsitan fœmina inermis?]

This neat species occurring with the last, and of the same or of rather less dimensions, so much resembles it in form, proportion, and sculpture, that we are compelled to regard it as of the same species, and as indicating either a variety with a rounded front, or, what is more likely, the female form. Portlock's original specimens are all of one character, and the front appears to have been really rounded, not broken off.

Locality.—Desertcreat, Tyrone.

4. *P. Jamesii*, Portlock, G. Report, pl. 3. fig. 10. (mala).

P. unciam latus; capite semicirculari, bis quam longo latiori, fronte angulato, marginato, crasso; glabellâ fere planâ tuberculatâ antice latissimâ postice ad didimium contractâ, lateribus rectis; lobo frontali latè triangulato, oculis impendente; cæteris radiantibus,—supremo maximo triangulato, medio lineari obliquo haud abbreviato, basali transverso; lobis omnibus fere ad medium glabellæ, spatio angusto interjecto, conniventibus; genis lente declivibus marginatis, angulis obtusis; oculis abbreviatis valde curvatis; (thorace — ?) caudâ [unâ cum capite congregata] rotundatâ, quam longâ tertiam partem latiori, depressâ; axi satis magno conico, marginem nullo modo attingente,—annulis 8–9; lateribus sulcis 6–7 æqualibus, leviter interlineatis.

Portlock's figure but imperfectly expresses the great width and flatness of the glabella, which is not the result of pressure; the tuberculation covers the glabella only, while the cheeks are merely granulated. The shape of the glabella and its radiating lobes, and the short curved eye, approximate this species nearly to the next, from which the glabella and pointed front of the head readily distinguish it. The head too is not so broad in proportion.

Locality.—Tyrone; in calcareous sandy schist, Waterford; also in sandstone at Newtown on the Suire, in the same county. [Geol. Surv. Coll.]

5. *P. alifrons*, Salter, in Appendix to Sedgwick's Brit. Pal. Foss. l. c. ii. t. 1 G. f. 12–14, M'Coy, ib. 159.

P. capite sesqui-unciam lato, gibboso, tuberculoso, antice truncato, bis quam longo latiori; glabellâ elevatâ sed parvum convexâ, ad basin angustatâ, superne dilatâtâ obtusâ, lateribus subrectis; lobo frontali brevi transverso limbum crassum impendente, et utrâque angulis

tumidis cum margine genarum confluentibus; lobis lateralibus tumidis, supremo subtriangulato anticè obliquo, reliquis fere rotundis brevissimis; genis declivibus tuberculatis marginatis, angulis rotundatis; oculis elevatis brevibus curvatis; pygidio semicirculari tumido; axi lato convexo 8-9-annulato, apice obtuso nec marginem attingente; lateribus convexis, costis 7-8, radiantibus simplicibus, margine angusto.

The peculiar character of this species, which a good deal resembles *P. sclerops* DALMAN, consists in the absence of any separating furrow between the upper lobe of the glabella and the outer margin of the cheek, the glabella thus seems to be drawn out into it on either side.

Localities.—Capel Garmon, Llanrwst; near Penmachno; Pont-y-Glyn Diffwys; and Bala; all in the Bala or Llandeilo rocks of North Wales.

6. *Phacops Jukesii.*—n. sp. [*P. sclerops*, var., DALMAN, Pal., t. 2. fig. 1 g. (mala)?]

P. capite unciam et plus lato, fere quam longo ter latiore, convexo (granuloso?); glabellâ haud elevatâ antice valde dilatâtâ, postice contractâ, utrinque tri-lobâ; lobo basali transverso lineari, secundo paullo majore rotundato, supremo magno triangulato, frontali maximo transverso toto oculo elevato brevi curvato imminente, lobo cervicali elevato nec lato; genis latis marginatis, [angulis rotundatis?]; sulco verticali fortè exarato; lineâ faciali impressâ; sulcis azalibus profundis.

This curious species, which we have only just now detected in the collections from Bala, differs materially from the next, in the comparatively equal size of the lateral glabella lobes. The upper one is large and triangular, but not nearly so large as in *P. conophthalmus*, and the second is distinctly rounded and larger than the basal lobe, instead of being contracted and almost lost, as in that species.

Locality.—Bala limestone, west of Gelli grin, Bala. [Survey Coll.]

7. *P. conophthalmus*, Bœck. sp. [*Calym. sclerops*, var. Dalman, Pal., t. 2. fig. 1 d?] *Tril. conicoph.* Bœck Gæa Norveg. (1838), 1. 4. *Phacops con.*, Emmrich Dissert. 21. *Asaphus Powisii* (head only), Murch. Sil. Syst., t. 23. f. 9. *Calym. Odini* (Eichw.), De Vern. Geol. Russ., t. 27. f. 8. *P. sclerops*, BURM., ed. 2. (1846), t. 4. f. 5. excl. syn. (icon bona, ab editione prima multo emendata.) *P. conophthalmus*, ib. p. 91. *Chasmops Odini*, M'Coy, l. c. t. 1 G. f. 22, 23. *P. conophthalmus*, ANGELIN, Pal. Suec. (1852) t. 7. f. 5, 6.

P. ovatus, magnus; capite valde transverso, fere quam longo ter latiore, granuloso, convexo; glabellâ convexâ, anticè valde dilatâtâ, postice angustâtâ, utrinque bilobâ, lobo mediano omnino contracto obsoleto, basali transverso lineari, supremo maximo triangulato, supra paulum sinuato; frontali rhombo-trigonalis maximo nec oculo imminente; lobo cervicali lato; genis convexis latè marginatis; angulis in cornua lata extensis [interius rotundatis] oculo brevi valde curvato; lineâ faciali impressâ; cauda (associata) lata punctata, vix marginata, axi conico, lateribus angustiore, 9-10 annulato; costis lateralibus 8 arcuatis, omnibus duplicatis.

This remarkable species is abundant in the Silurian strata on the Baltic coasts; it is equally common in Britain, but although fragments are abundant, we have only seen perfect specimens of the head in the Woodwardian Museum. I collected these in company with Professor Sedgwick, and with them was associated the tail above described, which could hardly belong to any other species. It is found with fragments of the head in some other localities, and agrees well also with that figured by Professor Burmeister. But the figure given by Angelin represents the tail as considerably more pointed, and we have specimens from Wales more of this character; there are other species of *Phacops* in which similar variations occur. The heads figured in the "Silurian System," from the Caradoc sandstone, belong to this species. Angelin has figured two other *Phacops* with very similar lobes to the glabella, but it is possible his *P. bucculenta* and *P. macroura* may prove but varieties of this.

We have seen the eyes of this species, and they are reticulated as in other species of *Phacops*. But from their greatly curved shape they are generally broken off, and this has led Professor M'Coy to the establishment of his genus *Chasmops*, which had better be expunged, as this group is so closely connected with the ordinary *Phacops* by means of such species as *P. Brongniarti* and *P. Jukesii*.

Localities.—In Bala Limestone; Llansaintffraid Glyn Ceiriog, south of Llangollen; Alt-yr-Anker, Meifod, North Wales [M'Coy], Welshpool [Sil. Syst.]; Llanfyllin, Montgomeryshire; Llanbedrog, Carnarvonshire [Survey Coll.]; Appletwhaite Common and Coniston, Westmoreland [M'Coy]. Caradoc Sandstone; Cheney Longville, Shropshire [Sil. Syst., figured specimen]; Acton Scott, &c., abundant.

Section ODONTOCHILE (Dalmannia), DECADE II. PL. 1.

Additional British Species.

P. mucronatus, Brongn. sp. *Entomostrac. caudatus*, Wahl. Nov. Act. Soc. Ups., v. 8. t. 2. f. 2. *Asaphus mucr.* Brongn., Cr. Foss. t. 3. f. 9. Dalman, Pal., t. 2. f. 3 a b. *Phacops*, Emmrich (1839), Diss. 24. N. Jahrb. 1845. Burmeister, ed. 1. p. 113., and ed. 2. (1846), p. 95. (excl. syn. Murch. "Sil. Syst.") Angelin, Pal. Suecica (1852), t. 8. f. 1.

P. triuncialis et supra; *glabellâ convexâ, anticè parum dilatâtâ, utrinque lobis tribus subæqualibus transversis, sulcis longis satisque profundis sese separatis; caudâ latè triangulari acuto, axi subconvexo limbum planum haud æquante, in 9-12 annulos et appendicem trigonalem divisio, appendice in apicem caudæ brevi-mucronatum percurrente; lateribus costis 7 planis, sulcis angustis acutis valde curvatis et cum tot lineis intermediis profundioribus ad apices confusis; margine angusto nec distincto.*

Portions of the head and perfect caudal shields of this rare species have been found in a stratum over the bed of volcanic ash at Pen-y-Rhiw, west of Bala, where it is to be hoped other collectors may obtain fresh specimens. The head is not complete enough to give the diagnosis. Our Bala specimens, as well as those from Sweden in Sir R. I. Murchison's cabinet, have but 9 rings and a triangular terminal portion to the axis of the tail, but in a specimen from Haverfordwest part of this terminal portion is annulated, and there are 12 rings. The lateral ribs are much arched at their ends, and strongly duplicate, of double furrows, each pair uniting at their tips in a broad depression. The apex is recurved; the mucro varies in length.

Localities.—Pen-y-Rhiw, west of Bala [Survey Coll.]; Haverfordwest, Pembrokeshire [Mrs. Day's cabinet]; in Llandeilo flags.

P. amphora, n. sp.

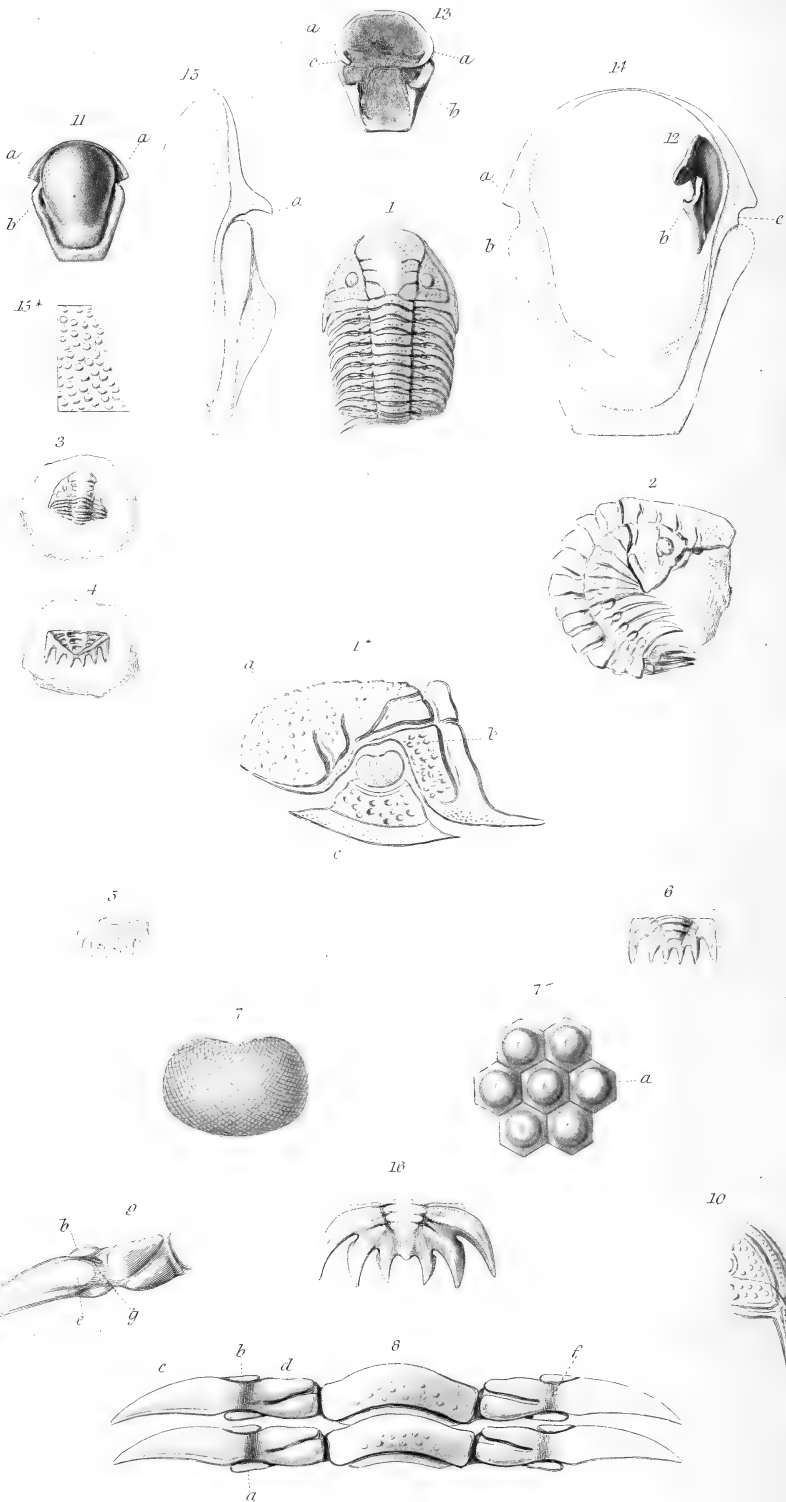
P. caudâ magnâ biunciali elongatâ, convexissimâ, fere semicylindricâ; sulcis axialibus fere obsoleteis; axi lato nec eminenti, marginem caudæ haud attingente, in annulos serdecim subplanos divisio, apice obtuso; lateribus valde curvatis deflexis, costis 14-15 planis, sulcis acutis separantibus,—costâ quâque lineâ medianâ lævi elevatâ (sub cortice impressâ!); margine angusto inflexo, apice obtuso (emarginato?).

Very like in general form to *P. truncato-caudatus*, Portl., from which it is at once distinguished by its convex form (almost like that of a half cask or barrel), and the axis not at all distinct from the sides—the axial furrow being almost obsolete; this latter character is very unusual in *Phacops*. Along the middle of each of the flattened side ribs a narrow and but slightly elevated ridge runs the whole length; on the internal cast this is represented by a depressed line of connected dots. Something similar, but less distinct, occurs in the allied species above quoted.

Locality.—Grug Quarry, near Llandeilo [Survey Coll.]; one fine specimen was presented by Mr. Williams, of that place. In Llandeilo flags.

J. W. SALTER.

August, 1853.



CHEIRURUS BIMICRONATUS. *Murchison.*

BRITISH FOSSILS.

DECADE VII. PLATE II.

CHEIRURUS BIMUCRONATUS.

[Genus CHEIRURUS. BEYRICH. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadaæ.) Head strongly trilobed; glabella with three lateral lobes, the basal ones circumscribed; eyes faceted; facial suture ending on the external margin; a rostral shield: Barrande. [Cheeks scrobiculate]; hypostome inflated, oblong, truncate, with a marginal furrow and lateral auricles; thorax of 11 joints, the pleuræ strongly nodular as far as the fulcrum, the ends free and pointed; tail of few, 3 or 4, segments, free at their ends.]

DIAGNOSIS. *C. grandis*; glabellâ superne latiori, sulco frontali et oculari obliquis propè medium glabellæ terminatis; lobis inferis trigonis (ætate rotundioribus) sejunctis; genis glabellâ angustioribus, oculis medianis, spinis posticis parallelis; thorace pleuris trituberculatis; caudâ parvulâ, utrinque pleuris tribus subæqualibus ad basin brevisulcatis, apicibus robustis, arcuatis.

SYNONYMS. Var. *α*. *Bimucronatus*—caudâ mucrone centrali nullo.

Calymene speciosa [DALMAN (1826), Pal., pp. 58, 76 ?] HISINGER (1840), *Lethæa Suecica*, Suppl. 2d. t. xxxix. fig. 2. *Paradoxides bimucronatus*, MURCHISON (1839), Sil. Syst., pl. 14. fig. 8, 9. MILNE EDWARDS (1840), *Crustac.*, vol. iii. p. 343. *Arges bimucr.* GOLDFUSS (1843), *Neues Jahrb.* 544. *Cheirurus bimucronatus*, BEYRICH (1845), über einige Böhmishe Tril., p. 18, 19. *Cheir. ornatus* (Dalm.), *β*, *bimucronatus*, BRONN. *Ind. Palæont.* (1848), 1. 286. *C. speciosus*, SALTER (June 1848), *Memoirs Geol. Survey*, vol. ii. pt. 1. pl. 7. fig. 4, 5, 6. *Ceraurus Williamsii*, M'COY (Dec. 1849), *Ann. and Mag. Nat. Hist.*, p. 408, *Pal. Foss. Woodw. Mus.* (1851), pl. 1 F. fig. 13.

VAR. *β*. *Centralis*, fig. 16.—caudâ mucrone centrali brevi, *Mem. Geol. Surv.*, 1. c. fig. 7.

The subject of our present notice received some degree of illustration in the second volume of the *Memoirs of the Geological Survey*, and we need not repeat here the figures which indicate the large size to which the species grew, but take advantage of a beautiful and nearly perfect specimen, found near Aymestry, and lent to us by the Rev. T. T. Lewis, whose valuable labours are so frequently

acknowledged in the "Silurian System." Messrs. Gray and Fletcher, of Dudley, have kindly enabled us to complete the details, and the figures in this plate are nearly all drawn from Upper Silurian specimens, while those previously given, with one exception repeated in this plate, were from the Llandeilo flags of South Wales.

The genus to which this rather common fossil belongs is highly interesting for the remarkable sculpture of the body rings, which are broken up into a number of prominent swellings divided by deep furrows, and have their ends freely extended into sharp points, which are so widely distant from each other, that it would require the animal to roll up to bring them into contact. The tail is made up of a few similar rings, cohering only at their base, and having the ends also free and pointed. The nature of the eyes also is worthy notice, inasmuch as they are covered by a faceted cornea, like that of *Phacops caudatus*, and not, as in most trilobites, with a smooth one. The facial suture, in this and one or two closely related genera, runs as it does in *Phacops*, to the outer margin of the head. The shell or crust is strong and calcareous, the furrows of the head well marked; the hypostome or labrum has a considerable resemblance to that of the genus above mentioned, and the number of rings in the thorax is the same—so that it is almost certain, much as the general appearance resembles *Paradoxides*, that there is a really close affinity between it and those species of *Phacops* which have the tail fringed with long spines.

Description.—One of the largest of trilobites; it measures occasionally 15 inches, and probably more, judging from the proportions of the large fragments previously figured* to that of perfect specimens of a smaller size. Those found at Dudley are not above one and a half or two inches long,—specimens from the Malvern are much larger. Length to breadth as three to two; the head occupies fully one third the length, and is a little broader than the body. General form moderately convex, and oblong, but narrowed suddenly towards the posterior end; the sides of the thorax and tail deeply serrated by the projecting ends of the segments. The animal is sometimes found half coiled up; the pointed ends of the pleuræ closing together and overlapping each other (fig. 2.)

Head rather more than a semicircle,—the obtuse front projecting; glabella gently convex, equal in breadth at the base to the cheeks, above considerably broader, marked with three strong furrows on each side besides the neck furrow, the lowest being

* Mem. Geol. Survey, vol. ii. pt. 1. pl. 7.

directed obliquely downwards and joining the neck furrow before reaching the middle ; it thus encloses a spherical triangle as a basal lobe. In older specimens this lobe is somewhat squarer, and the furrow more curved. The other furrows curve but little downward, and are variable in length, but usually extend more than one third across the glabella on each side. The furrows on the glabella, as well as the axial furrows, are sharp, but not broad or deep exteriorly, although they are so on casts of the inner surface. Fore-head lobe of moderate size, half as long as the entire glabella, and on the sides overhanging the other lobes,—in front it is somewhat produced and occupies all the margin. The glabella is neither gibbous nor depressed, a line taken from the front edge to the neck furrow presenting a regular and gentle convexity. Cheeks subtriangular, not so wide as long, with a broadish margin distinctly separated by a furrow, which meets the strong straight neck furrow at the posterior angles ; these angles are spinous, the spine short and directed backwards. The eye is placed more than half-way up the cheek, and not close to the glabella, it is opposite the middle furrow,* and is rather small, supported by a raised rim below ; the eyelid is narrow and indented,—the lentiferous surface (fig. 7) very convex, supine, and covered with minute, closely set, convex facets with no spaces between them. Our figure, 7*, represents each facet as with a minute pit upon it, but this is due to wear, (at *a*, a lens is seen in the natural condition). Above the eye the facial suture takes a sigmoid curve, and cuts the margin exactly where the axial furrow ends on it ; below the eye it turns directly downwards to the smooth border, which it cuts considerably in advance of the posterior angle, and in an oblique direction, so that it reaches further back on the lower side than on the upper. We do not know the course of the suture in front,—it is probably direct across, beneath the front margin, leaving the cheeks united there, as in *Sphaerexochus*, next described. The surface of the glabella is sparsely covered with small granules (fig. 1*, *a*) ; the cheeks are largely scrobiculate, (*b*, *c*), and the wings or free cheeks have their border smooth and only scabrous on its outer edge ; they sometimes, as fig. 10, dilate a little in advance of the facial suture. Hypostome (figs. 11 to 15) large, ovate, oblong, very convex, its length one fourth more than the width, but in appearance more ; broadest near the base of insertion, from which the central convexity rises immediately and reaches

* Lovén calls the upper furrow "*frontalis*," and the middle one "*ocularis*," and, though not always strictly correct, it would be a very useful designation. We have employed it above in the diagnosis.

nearly to the tip. A rather narrow ring or rim surrounds the apex and sides, terminating abruptly near the base on each side in what may be called an auricle, followed by a deep notch *c*, above which the ascending processes *a*, *a*, take their origin. The apex of the hypostome is truncate, the corners angular or even mucronate. A distinct sulcus separates the border all round, and within this there is a short oblique furrow on each side. Its whole surface is closely scabrous (fig. 15*); the convex portion has besides scattered larger granules. The organ is hollow when viewed from the inner and under side, and the structure there observable is such as has been often described.* These are two ascending processes, *a*, *a*, rising from the ends of the basal or front margin, and directed obliquely backwards; and on the sides, *b*, *b*, the inflated broadly triangular portions characteristic of the genus. These triangular curved plates give the appearance of thickness on viewing the organ from the side (fig. 12), but the general surface on the inner side is concave, answering to the great convexity of the outer side. Thorax much longer than the head, but narrower, and for most part of it parallel sided, of 11 gently convex rings which are very minutely scabrous; the axis is narrower than the glabella, of nearly equal width all the way down, but scarcely so wide as the pleuræ. These are linear and directed straight outwards for two thirds their length, then curved a little backwards and tapering to a sharp point. The fulcrum, placed at about one third, is of singular structure,—a small semi-oval piece (fig. 8, *a*) is attached to the posterior edge of each pleura, and against this piece abuts a similar tubercle (*b*), placed on the front edge of each, and the two pieces, forming together a narrow oval tubercle, are insulated by a deep sulcus from the body of the pleura, which is also constricted and furrowed across at this point, so as to have the outer and pointed portion (*c*) quite distinctly separated from the small inner one. The latter (*d*) is very strongly divided into two tumid lobes by a short oblique sulcus, and just beyond the constriction the outer portion rises into a stout boss, (fig. 9, *e*) giving the tri-tuberculate form characteristic of the genus.

* M. de Barrande, Neues Jahrbuch (1847), 389, has given a full description of the hypostome of *Cheirurus*. He describes the ascending processes *a*, *a*, (Flügel), as bent upwards at right angles to the surface of the organ, and uniting with the upper crust along the line of the dorsal or axial furrow, with a broad base of attachment, reaching from the upper to the middle glabella furrow. In *Phacops* it has nearly the same position. He also describes a second organ, of the same size and shape, but less convex in all its parts, lying immediately behind the hypostome, between it and the upper crust of the head. This organ he calls *epistoma*; and he has seen it both in *Cheirurus insignis*, and a species of *Phacops*. It has never yet occurred to our observation.

The line of the fulcral points is parallel to the axis for all its length, and the constriction beneath them, though not very marked on the upper crust (fig. 8), produces a longitudinal ridge on the under surface, and a strong furrow in casts (fig. 9). Tail, at least in Dudley specimens, very much narrower than the body, with three strong spinous lateral lobes on each side directed backwards, the outer ones a little divergent and longest; all extend equally backwards,—the tail is therefore truncate—but exclusive of the spines, it is broad triangular, following somewhat the shape of the axis; it is marked on each side by four short deep puncta or furrows, which do not run to the margin in young individuals. The axis is convex and short conical, of three distinct ribs and a small terminal piece—the last very obscurely indicated; there is no mucro between the lowest spines in the ordinary Wenlock forms.

Variations.—The following have been observed. In a Dudley specimen the front or forehead lobe occupies much more than half the length of the glabella, the side lobes being therefore more crowded. In a Dudley specimen, a large tubercle occurs in the middle of the forehead lobe. In some individuals the glabella widens more above, in others it is nearly parallel-sided, and the lateral furrows vary in length. The head spines occasionally reach the third thorax segment. The margin of the cheek in one specimen is notched at the facial suture (fig. 10, *a*). The axis of the thorax is, sometimes, though rarely, as wide as the pleuræ. The most important variations occur in the tail,—in fig. 5, we have represented the spines as all directed backwards, and the two central ones closely approximate; they are so in the large Ledbury specimen figured in the “Silurian System,” where too they are shorter than the outer spines. In fig. 6, they are a little space apart; in a Lower Silurian specimen we have seen a small tubercle appear between, and in our var. β a decided, though short, mucro protrudes. Lastly, as a monstrous variety from the Silurian rocks of Kildare,—we have reason to think it of the same species,—we have one with a wider interval, and a bifid mucro. In old specimens, as well as in var. β , the spines diverge much more than in those we have here figured. Perhaps some of these variations are due to sex.

Affinities.—The considerable variations above mentioned lead us to believe that the *Ch. insignis*, Beyrich, may be but a variety of this species. We have not materials enough to justify our recording it as a variety, as Beyrich describes and figures it as with a much wider glabella, the furrows reaching but a short way across. The hypostome is very similar, and the tail differs very little, except in

the much greater central mucro and more divergent spines, towards which characters we have shown considerable approaches in some of our varieties. It was these close resemblances which induced us to say, in the volume already alluded to, that our British species occurred in Bohemia with the *C. insignis*. But I find the Bohemian specimens do not show any tendency to vary towards ours.

Barrande, in his great work which has just been published, figures a fine new species, *C. Quenstedti*, closely allied to both the above, but the head spines are very much longer and slenderer, and so are those of the tail; the glabella too is parallel-sided, its furrows run quite across, and the lower pair of lobes nearly meet. *Calym. ornata* of Dalman, since fully described by Lovén, must be very nearly like our species; but the greatly elongated first pair of spines to the tail, and the parallel-sided glabella must separate it for the present; we subjoin a note giving a few of its prominent characters.* *Ch. obtusicaudatus*, Corda, is another nearly allied fossil.

History.—The history of the species dates clearly, we think, from Hisinger's *Lethæa Suecica*, where the head of a large specimen is figured, and the species considered identical with the *Calymene speciosa* of Dalman, found by Nillson in the isle of Oeland. There is, however, some doubt of the correctness of this reference. Dalman described in a supplementary note to his "Palæadæ" two species, *C. speciosa* and *C. clavifrons*, comparing the former with the *Trilobites Sternbergii*.† This comparison sufficiently indicates that a large species, with the glabella broad in front, must have been intended; and we lay the more stress on this, because it proves that the species with a small oval glabella, narrowed in front, which was figured by M. Sars in Oken's *Isis*, 1835, as *C. speciosa* of Dalman, is not that species, and could never have suggested the comparison above mentioned. We believe it was this erroneous reference by Sars, joined to Dalman's rather loose description, "smooth, large, oval, and convex glabella," which has thrown doubt on the identity of his species with Hisinger's figure. But since there are several species of the genus found in Norway and Sweden, as indicated by the figures of M. Sars, above quoted, and those lately given by

* Glabella æquilata; abdomen articulis 3, basi connatis; primo secundum longè superante, in appendicem crassam teretem longissimam utrinque producto; secundo tertium excedente, hoc verisimiliter brevissimo. Loc. Husbyfjol, Ostrogothia. Lovén in *Ofversigt Vetenskaps Akad.* (1844), p. 64.

† Sternberg, *Verhandl. Vaterlands, Mus. Prag.* 11th pt., p. 45. tab. 13 a. Dalman says, that in his species "the glabella lobes are all connected down the middle, while in Sternberg's they are separated by transverse furrows."

Angelin in the "Palæontologia Suecica," we prefer with Dr. Beyrich,* to leave the question undecided, and wait for the descriptions and references now in course of publication by M. Angelin.

Sir R. I. Murchison first published it in this country, referring it to *Paradoxides*, as the only genus then published which it appeared to resemble, especially as he regarded the two lower prongs only as constituting the tail; he also figured the body rings, and commented on their remarkable rough sculpture; this figure of the body is accidentally reversed upon the plate, the portion nearest the head being turned downwards.

It is next mentioned by Lovén in 1844, describing two of Dalman's species, the *C. clavifrons*, and *C. ornata*, and to the latter he referred the figures given by Murchison of the present species. But the comparison could be made only with the body segments, and these are far too much alike in different species. The description too of the head given by Lovén, though agreeing in the main with the perfect examples we now possess, is not sufficiently precise, and we are not therefore justified in reuniting ours with *C. ornata*, more especially so, as the excellent figure of that species lately given by Angelin, Pal. Suecica, p. 21, fig. 1, represents the uppermost or forehead lobe of the glabella as not wider than the rest, ("equilata glabella," Dalm.), or occupying nearly so much space in length as in our species.

It is to be regretted that to these descriptions, the author has not added that of *C. speciosa*; he does not even mention this disputed species. In 1845, Dr. Beyrich first described the entire animals of this genus, and introduced the British fossil as an undoubted species of *Cheirurus*, leaving for future observation its identity or otherwise with his *C. insignis*, to which, as above stated, it bears great resemblance.

It was again published in the second volume of the Memoirs Geological Survey, 1848, where the head of the species was described and identified with *Calymene speciosa* of Hisinger. And we still regard Hisinger's excellent figure as a proof that our species is found in Gottland, in a stratum marvellously like our own Wenlock limestone. In that notice the very large size the species attained was represented, and we accidentally repeated the error of reversing the position of the body ring by turning the front edge downwards. Lastly, Professor M'Coy, in one of his useful contributions to the "Annals of Natural History," described the entire animal, which he has since figured in the Synopsis of the Woodw. Mus. fossils,

* Untersuch. über einige Böhm. Trilob. (1845), 1st part, 1. p. 17, 18.

retaining the generic name *Ceraurus*. We had previously selected this beautiful example from the collection of Mr. Williams, who found it near Llandoverly, and we have since again examined it. It is much elongated and narrowed upon the cleavage of the rock, but is identical with the present species, and is very interesting as showing that the Lower Silurian form is somewhat intermediate, as regards the tail, between the ordinary Dudley form and our var. β , for the lower prongs are but slightly distant, and have but a tubercle, instead of a prominent mucro between them.

Barrande's exquisite figures of the genus, fortunately now before us, show the structure of all parts of the body completely. He has figured the hypostome in several species; we are fortunate in here being able to add the under side of that organ, and the structure of the eye.

British Localities and Geological Range.—LLANDEILO FLAGS to AYMESTRY LIMESTONE.—In Llandeilo flags; Sholes Hook, and Pelcombe Cross, Robeston Wathen, and Llandowror, near Haverfordwest; Goleugoed, Llandoverly, (Cambridge Museum). In Bala limestone; Rhiwlas and other localities, near Bala, North Wales; Chair of Kildare, Ireland. In Lower Silurian rocks, at Mullock, Girvan, Ayrshire, (Coll. Sir R. I. M.) In Woolhope limestone; Nash Scar, Presteign, (Coll. Mr. Davis.) In Wenlock limestone; Haven, near Aymestry, (Coll. Rev. T. T. Lewis); Brand Lodge, Malvern; Dudley; Dormington Wood, Woolhope. In Aymestry limestone; Downton Castle, Ludlow.

Var. β .—In Wenlock strata; Nelson's Tower Wood, east of Carmarthen.

Foreign Distribution.—Gothland, in Upper Silurian (HISINGER); (Celand, Lower Silurian, DALMAN?).

EXPLANATION OF PLATE II.

- Fig. 1. Specimen, perfect except the tail, from Haven, near Aymestry; in the collection of the Rev. T. T. Lewis, of Bridstow, Ross.
- Fig. 1*. Head of same, dissected, showing the granulate glabella, *a*, and deeply pitted cheeks, *b*, *c*. (the eye is raised too much.)
- Fig. 2. From Dudley, collection of J. Gray, Esq. A fine half coiled specimen, showing the whole 11 rings, and the small tail.
- Fig. 3. Same locality and collection. Very young coiled specimen.
- Fig. 4. Same locality and collection; showing the under side and incurved edge of the tail, with the spines a little more apart.
- Fig. 5. Tail of young specimen, from Dudley; collection of T. W. Fletcher, Esq. It has the posterior spines approximate.
- Fig. 6. Same locality; collection of J. Gray.

Fig. 7. Eye, magnified.

Fig. 7*. Do., still more highly magnified; the facets are convex; and at *a*, one is in its original condition; the pits on the others are due to wear.

Fig. 8. Two thorax joints of Aymestry specimen (fig. 1); at *a* and *b*, the curious tubercles at the fulcral point are seen; *c*, is the outer spinose portion; *d*, the inner bilobed part; they are separated by a furrow, *f*.

Fig. 9. Specimen from Nash Scar, Presteign, collection of J. E. Davis, Esq. This is an internal cast, and shows the outer tubercle *e*, and the furrow *g*, more strongly than in fig. 8, which has the crust on.

Fig. 10. Under view of cheek from the same specimen (as fig. 9); it has an unusual swelling above the facial suture *a*.

Fig. 11. Perfect hypostome (collection Geol. Surv.), from Dormington Wood, Woolhope; *a*, the lateral ascending processes; *b*, the marginal wings.

Fig. 12. Side view of do.; the incurved triangular plates are shown at *b*, the lateral notch at *c*.

Fig. 13. Under view; *a*, *a*, the "ascending processes," which are attached to the under surface of the glabella at its sides; *b*, *b*, the incurved triangular lateral plates, possibly for the attachment of muscles; *c*, the hollow space under the ascending processes, answering to the lateral notch in fig. 12.

Fig. 14. Outline of the largest hypostome we have seen, from the Lower Silurian limestone of Kildare, Ireland; the letters are the same as in fig. 11.

Fig. 15. Lateral view of the same.

Fig. 16. Var. *β*, *centralis*, from the Wenlock strata of Nelson's Tower Wood, Llandeilo.

Remarks on the Genus.

It seems necessary to contend for the generic name adopted here, because a rigid adherence to priority would compel us to relinquish a name now familiar to naturalists, and bestowed by Beyrich on a group which he had carefully investigated and fully described. Now that Hall has given such excellent figures of *Ceraurus*, we know perfectly well what was meant by the obscure and imperfect plaster cast published by Green under that name. But the original description was scarcely more than sufficient to indicate that it was a trilobite, and consequently it has been referred with doubt to various genera by Beck, Beyrich, Lovén, Portlock, and Burmeister. A genus so ill constructed and imperfectly described, can have no authority; and it would be unjust to substitute such names for those given by the first real describers. The same rule we think fully justifies us in rejecting *Zethus* of Pander, a name lately revived by Dr. Volborth*; for the genus as constituted by Pander consists of two species, to either of which the meagre and incorrect description will apply; the first† of these being, by Dr. Volborth's own admission, a species of *Cheirurus*, the second a *Cybele*‡. He would restrict the name to the latter; but custom and the opinion of naturalists in general would point in doubtful cases like this to the first as the typical species, and we should then have to apply *Zethus* to all we now call *Cheirurus*; more especially as it was the *Cheirurus* only of which Pander knew the entire body. He describes it as having 16 ribs in thorax and tail together, the segments of the tail being free like those of the thorax; this is untrue for either genus; and he denies any trace of eyes. Of the *Cybele*, a fragment only is figured, and Pander even doubts whether it belongs to the genus, so that he evidently intended the first for his type; and had either his figure or description been intelligible, or had he referred to Sternberg's or Dalman's species as cognate, his name ought to have been retained. But we believe the right of priority of name, rather than that of description, cannot with advantage be so rigidly enforced, and we accept *Cheirurus* as the first intelligible description, as well as the clear definition of a remarkable group. With regard to the affinities of the genus, we have

* Transactions of the Royal Mineralogical Society of Petersburg (1847.)

† *Z. multiplicatus*, Pander.

‡ *Z. verrucosus*, Pander.

Zethus, was prescribed for a species of *Cheirurus*, by Fabr. 1804

come, as above stated, to the conclusion that it must be considered nearly related to *Phacops*. Barrande, in his ingenious and simple arrangement of the groups lately published,* places *Cheirurus* among the series which he defines as having the "plèvre à bourrelet;" and certainly it is most closely allied to some genera, *Sphærexochus*, *Cybele*, &c., which possess this character. But an inspection of our plate will show that the characteristic furrow ("sillon") of the pleuræ is only shortened, not absent in this genus. In several Bohemian species it is quite evident, and in the *Cheirurus claviger*, which Corda elevates to the rank of a genus, the furrow continues along the whole length, as it does in most trilobites; and we may state generally, that we believe this character to be merely a special modification, since all pleuræ have the furrow, either bisecting them as in the ordinary form, or so near the anterior edge as only to separate a mere line for the front or fulcral portion. † In *Sphærexochus*, the nearest ally of the genus we are considering, it is not, perhaps, indicated at all. We think, therefore, that the other characters which we regard as of more importance, viz. the structure of the eyes, and the course of the facial suture, will connect *Cheirurus* with *Phacops*. But with respect to the limits of the genus, we are strongly inclined to think *Sphærexochus* ought not to be separated from it, since such species as *Ch. clavifrons* of Dalman, and *Ch. globosus* of Barrande seem exactly intermediate, having the head of *Sphærexochus* and the tail of *Cheirurus*. However, if we allow the striking character of the thorax rings to guide us, we shall find it agree with the habit in marking out three distinct genera already recognized, viz.—

Eccoptochile. Corda. Cheeks scrobiculate; pleuræ 12, furrowed; hypostome with lateral furrows:

Cheirurus. Beyrich. Cheeks scrobiculate; pleuræ 11, nodulated; hypostome with lateral furrows:

Sphærexochus. Beyrich. Cheeks not scrobiculate; pleuræ 11, simple, rounded; hypostome without lateral furrows:

And the species which have globose glabella, but still have the 11 nodular pleuræ, will remain in *Cheirurus*, not in *Sphærexochus*, just as we find this variation in the glabella of *Phacops*, while the characters of the thorax remain the same.

The genus is Silurian and Devonian; it does not rise into the Mountain Limestone.

Other British species of CHEIRURUS.

SECTION CROTALOCEPHALUS.

Glabella furrows continuous across, all strong and distinct.

1. *C. articulatus*? [*Calym. articulata*, Münster. Beitr. Heft, 3. pl. 5. fig. 7?] *Ch. Sternbergii* (Münst), PHILLIPS, Pal. Foss., fig. 247.

I do not venture to characterize this species from the imperfect fragments we possess. The glabella is long, narrow, and scarcely clavate forwards, and not very convex. The upper and middle glabella furrows are very strong, and go right across, and the basal lobes are narrow, triangular, transverse, and they nearly meet in the middle of the glabella, leaving but a small space between.

The latter character I suspect to have been much exaggerated by Münster, in the figure above quoted, who has represented the basal lobes as forming one transverse piece. Our rare British fossil is certainly more like this figure than the *C. Sternbergii* of the same author, in which the furrows are partially obliterated in the middle, and the glabella is broader.

Locality.—Barton, S. Devon (Phillips); Newton Bushell, in Devonian limestone. Presented by R. A. C. Austen, Esq.

* *Système Silurien de la Bohême*, 1853. Also *Ann. and Mag. Nat. History*, Sept. 1850.

† This narrow line may certainly be seen in *Acidaspis* and *Cybele*; in *Bronteus* it seems to have completely vanished.

SECTION CHEIRURUS proper.

Glabella with the furrows all distinct, but not meeting across.

2. *Ch. speciosus*. Dalm. sp.—above described.

3. *Ch. gelasinus*, Portlock. *Amphion gelas.* id. Geol. Rep., t. 3. fig. 4. (head); and *Arges planospinosus*, pl. 5. fig. 9. (tail). *Cheirurus*, BEYRICH (1845), Böhm. Tril., 1. p. 19. Salter (1851), Quart. Geol. Journ., vol. vii. pl. 8. fig. 1. *Cheirurus planispinosus*, Bronn. Ind. Pal. (1848).

Ch. depressus, capite transverso, glabellâ rectangulari sulcis brevibus transversis, lobo frontali brevi, basalibus oblongis transversis vix circumscriptis, uno ab altero spatio equali sejuncto; genis latis, marginibus depressis, spinis brevibus; caudâ (hic haud dubie refertâ) latâ, segmentis utrinque tribus latis, ad basin longe adnatis; acuminatis; primo in appendicem longam producto secundum longe excedente, hoc tertium brevem superante; axi 4-annulato, articulo ultimo minimo angusto, nec apicem caudæ profundè emarginatum attingente.

The upper lobe of the glabella is not at all broader—sometimes it is narrower—than the rest; and in the furrow beside it there is a very deep indentation. On the under side of the crust this would be a strong ridge, to which, as Barrande has shown, the processes of the hypostome are attached. The transverse form of the head, especially the wide cheeks, easily distinguish this from any other species. The surface of the glabella is smooth, or nearly so.

There can be little doubt that, as Beyrich has suggested, the head and tail belong to one animal. They are alike broad and depressed, and agree in size, while no other species of the genus occurs with them.

Locality.—Co. Tyrone, head and tail; limestone of Ayrshire, head only. [Presented by Mr. C. Moore.]

4. *Ch. cancrurus*. sp. n.—*Ch. satis magnus*, caudâ lineas 20 latâ transversâ, apice abruptè truncato præmorso; axi lato, annulis quatuor subæqualibus, tertio à quarto punctis binis remotis solum separato; lateribus spinis quatuor longis sub-parallelis, ad basin adnatis, transversis, apicibus lente decurvatis; basalibus utriusque lateris longo intervallo remotis.

A most remarkable species, in which the four lateral lobes of the tail start horizontally from the broad axis, instead of gradually converging beneath it, and leave its apex bare; the breadth of this space being increased by the outward direction of the spines themselves, which begin to curve downwards only when they have attained half their length. The appearance of the perfect tail is just like that of a crab; *præmorso* might have been an appropriate specific name. *C. obtusatus*, a Bohemian species, somewhat resembles this, but the spines are radiating, not parallel.

There is a rare cephalic shield in the Chair of Kildare limestone, which may very probably belong to this species; it is as unusual in its character as the tail we have described. It is the *Ch. gelasinus* of M'Coy's Synopsis Sil. Foss. Ireland, 44. The cheeks are scrobiculate, and the eyes forward, the glabella smooth, clavate, long, and narrow; the neck furrow trends upwards towards the middle on each side; the basal furrows curve downward, but do not meet the neck furrow, or quite circumscribe the subtriangular basal lobes; the middle furrows are strong and transverse, the upper pair apparently obsolete (probably some faint traces of them may be found.) But there is enough to distinguish the species as a very curious one, and provisionally I refer it to the *C. cancrurus*, with which it agrees well in size.

Locality.—Limestone of the Chair of Kildare in Ireland. [tail in Survey coll.; supposed head in the cabinet of Mr. R. Griffith.]

5. *C. octolobatus*. M'Coy's Synopsis Pal. Foss. Woodw. Mus., t. 1 G. f. 10. [Mem. Geol. Surv., vol. ii. pt. 1. pl. 7. fig. 36, without name.]

C. pygidio transverso elliptico semiunciali, bis quam longo latiori, margine octolobato; axi depresso, annulis tribus, duobus superioribus subæqualibus, tertio lato a limbo terminali punctis

binis solum distincto, lateribus planis, lobis anticis curvatis et distinctis, reliquis ad basin connatis, apicibus ornatis.

Locality.—Bala limestone; Bala, frequent; Hendre wen, Cerrig-y-druidion, Denbighshire.

SECTION ACTINOPELTIS. Corda.

Glabella inflated, the upper lobes indistinct.

6. *Ch. clavifrons*, Dalm. sp. ? [*Calymene*, Dalman, Palæad. 59. not of Hisinger. Lovén Ofv. Kongl. Vetensk. Akad. (1844), 63, 64 ?] *Sphærexochus juvenis*, Salter (June 1848), Mem. G. Surv. vol. ii. pt. 1. pl. 7. fig. 1-3 (exclude 3 b). *S. clavifrons*, ib. Errata, p. viii. *Cheirus clavifrons*, in Appendix, Pal. Foss. Woodw. Mus., t. 1 F. fig. 11, and 1 G. fig. 9. *Ceraurus*, M'Coy, ib. 154 (1851.)

C. capite sesquiuicuali semi-elliptico, in juveni rotundiore, convexissimo; glabellâ maximâ ovali gibbâ, genis latiore, granulosa; sulcis duobus anticis brevibus obscuris, basali profundo fere ad cervicalem decurvato lobumque subovatum ambiente; genis declivibus scrobiculatis brevi-spinosis; caudâ axi longo, 4-annulato, articulo ultimo rotundo, lateribus utrinque trispinosis, spinis valde inæqualibus vix basi connatis, primo ad basin lato, brevisulcato, secundum longe superante, hęc integro angusto tertium brevem sæpe obsoletum multo excedente; spinis omnibus retrorsis subparallelis.

The glabella, when perfect, shows small regular granules or tubercles widely scattered all over it. The punctations too on the cheeks are rather small, and scattered.

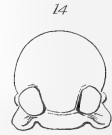
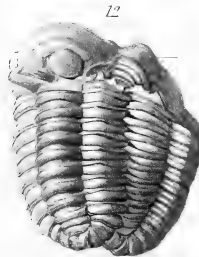
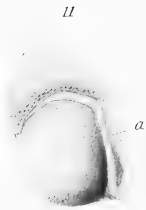
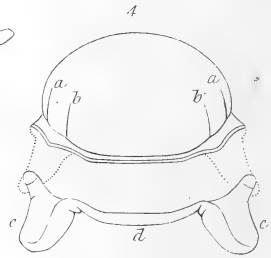
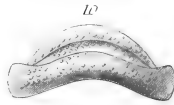
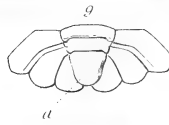
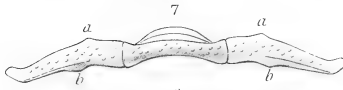
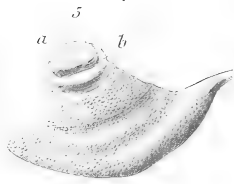
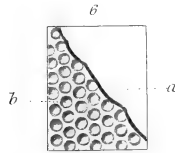
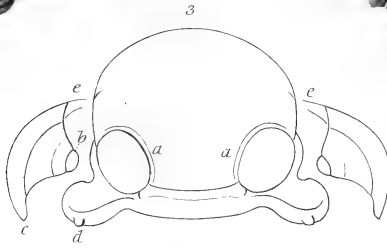
The terminal spines of the tail in some specimens are very short and obtuse, and the whole tail is in some shorter and broader than in others, even from the same locality, and the spines consequently more divergent at their bases.

There are some points of difference between our fossil and that which Lovén has carefully described from Dalman's original specimen and we may have again to recur to the name *juvenis* as above quoted. The Swedish species is described as having long straight head spines, the glabella nearly as wide as the cheeks. Ours, now that we have more perfect specimens of the head and caudal shield from Ireland, shows short head spines, and the inflated glabella is certainly wider than the cheeks. In all other respects Lovén's description applies well. By the description also of the tail of the *C. ornatus*, Dalm., given by the same author with the above, it would appear that this species had a caudal shield precisely similar to that of ours.

Localities.—Llandeilo and Bala rocks; in South Wales, Sholes Hook, Haverfordwest. In North Wales, Bala, abundant; Cader Dinmael, Denbighshire; near Llanfyllin, Montgomeryshire—in Upper Bala beds; in Westmoreland, Applethwaite Common; in Ireland, Chair of Kildare,—frequent, and of large size.

J. W. SALTER.

August, 1853.



SPHÆREXOCHUS MIRUS - *Bevrich.*

BRITISH FOSSILS.

DECADE VII. PLATE III.

SPHÆREXOCHUS MIRUS.

[Genus SPHÆREXOCHUS. BEYRICH. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palædæ.) Eyes faceted? "Head very convex, the cheeks not scrobiculate; facial suture ending on the external margin near the angles, in front continuous and submarginal; glabella large and nearly spherical, with three furrows on each side, the two upper very obscure, the lower strong and curved down to the neck furrow; thorax of 11 joints, without any furrows; tail of 3 segments, free at their ends;" hypostome subtrigonal, with a marginal furrow, but without lateral furrows. No rostral shield.]

DIAGNOSIS. *S. granulosis*; "*glabellâ lobis infimis profunde circumcinctis, paululum tumidis,—spatio interjecto diametrum eorum superante; caudâ pleuris tumidis.*"

SYNONYMS. *Calymene clavifrons*, HISINGER (1840), Leth. Suec., Supp. 2d. t. 37. fig. 1 (not of Dalman.) *Sphærexochus mirus*, BEYRICH (1845), über einige Böhm. Tril., p. 21. *S. mirus*, *ibid.*, Zweite Stück (1846), t. 1. fig. 8. *S. calvus*, M'COY (1846), Syn. Sil. Foss. Ireland, pl. 4. fig. 10. *S. mirus*, CORDA (1847), Prodröm. einer Monog. Böhm. Tril., fig. 72. BARRANDE (1853), Syst. Sil. de Bohême, vol. i. pl. 42. fig. 11-18.

We are indebted to Mr. John Gray for the fine Dudley specimens which figure in this plate, and to Mr. Fletcher for those from which the details are drawn. Fragments and detached heads are not uncommon; but these are the only perfect British specimens we are acquainted with. The species is cosmopolitan, at least it ranges from Bohemia to the Western States of America, and in our own country is found both in Upper and Lower Silurian rocks.

Description.—The animal is capable of rolling itself into a complete ball, of which the large head forms a very conspicuous part. The general form is oblong; the length of English specimens usually about an inch and a half, and the breadth ten lines; they never appear to reach the length of two inches.

The head is more than one third the whole length, and the glabella is very large, occupying, as seen from above, four fifths of the width,

and quite overhanging the narrow front margin. It is, excluding the neck segment, nearly a true hemisphere, and has a pair of large orbicular lobes at the base, deeply circumscribed, and further apart from each other than their own diameter. The furrow that bounds each of these lobes is broad, sharp, and equal in depth all round, leaving no communication with the body of the glabella (fig. 3, *a*, 11 *a*). Above these lobes on each side are two faint impressed lines which represent the upper furrows (in fig. 4); of these (*a*) the one next to the round basal lobe is placed at a less distance from it than the diameter of that lobe, at about the point of the head's greatest width, and the upper one (*b*) at an equal distance in advance of it towards the front. The cheeks are small in comparison with the glabella, and hang vertically from its sides (fig. 4, *cc*), like a pair of lappets from a cap or helmet; they are oblong and have a thickened margin. The small convex eye is placed very near the glabella, and below the middle of the head; the facial suture runs from it outwards, and reaches the exterior margin which it cuts obliquely a little in front of the posterior angle, as at fig. 3, *c*; in front of the eye it continues parallel to the glabella, and runs along the edge of the narrow front margin, leaving the free cheeks connected beneath by a narrow band (fig. 4, *d*). Each free cheek is hatchet-shaped, and the small eye (fig. 5, *a*) occupies the inner corner, supported on a fold of the crust, *b*, which truncates, or even indents it below. The eye is thus pushed up into a supine position; it is short, oblong, and very convex. The lenses are numerous, larger in size than the granulations of the general surface, and placed near together, less than half their diameter apart. In this specimen we have not the outer surface sufficiently perfect to enable us to say whether the cornea is raised into facets (as Barrande thinks) or not; the surface is therefore left blank (fig. 6, *a*); from the inferior surface, *b*, the lenses have fallen out, leaving pits which indicate their size. The posterior corners of the head are rounded off and contracted to a less width than the free cheeks, and they bear instead of a spine, only a small tubercle (fig. 3, *d*), which is placed far inwards.

The hypostome has not yet been found in England, but it is figured in M. de Barrande's* plates. It is subtrigonal, straight at the base, where it is much broader than it is long, and the apex is

* If this figure be as complete as M. de Barrande's figures usually are, there is no lateral notch nor any visible ascending processes. M. Corda's figure, however, exhibits a narrow rim at the base, with a small lateral process on each side. The notch would then exist between the lateral border or wing (flügel), and these small processes and the resemblance to *Cheirus*, in other respects so closely allied, would be more complete.

rounded and slightly emarginate. A broad shallow furrow runs round the end and sides, leaving only a small central convexity of the same shape as the hypostome; this convexity is not indented by any lateral furrows.

The surface of the head is covered by a fine close granulation (fig. 11), which occupies also the free cheeks or wings (fig. 5); it is therefore one of the generic distinctions from *Cheirurus*, in which the cheeks are always pitted or scrobiculate.

Thorax parallel sided, scarcely tapering backwards, of 11 thick rounded rings; the axis as wide as the sides, and of equal breadth throughout, very convex; each joint much raised and rounded (see fig. 10). Pleuræ horizontal as far as the fulcrum (fig. 7, *a*), and then abruptly deflexed, and from this point the pleura tapers outwards to a conical blunt point, which at the extreme tip is a little bent forwards. The fulcrum is placed at rather less than half-way from the axis, but in the last segment (fig. 8) it approaches much nearer,—to about one third. Its place is indicated by a protuberance both on the forward and hinder edge of each segment (fig. 7, *a* and *b*), but these swellings are not isolated tubercles as in *Cheirurus*, nor are there any oblique or longitudinal furrows on the pleuræ, as in that genus, to break up the uniform convex surface of the segment.

Tail about semicircular, truncate; the axis conical, its base of two depressed close-set rings, its apex of one long triangular joint, which is separated from the second joint by a deep depression; from thence it is flattened, or even depressed for some distance, but suddenly rises to an obtuse and elevated tip (fig. 9, *a*); which, seen sideways, presents the appearance represented in fig. 2, where *a* is the obtuse tip of the axis. The sides are composed of three obtuse convex lobes which scarcely project on the margin; the upper one follows the bend of the hindermost pleura, the second is less curved, the third parallel to the axis; all are deflected so that an end view of the tail (fig. 13) presents an angular figure.

The entire surface of the thorax (fig. 10) and tail, like that of the head, is covered with a fine granulation, the grains of equal size throughout.

Variations.—Our Dudley specimens have the tail somewhat shorter and wider, and the terminal joint of the axis therefore shorter, than those from Bohemia. Irish specimens (figs. 14, 15) are more like the foreign ones in this respect. The space between the lower glabella lobes is least in these Irish specimens, though some of them have it considerably wider than the diameter of the lobes; in a Wexford specimen, the space is proportionally as wide

as in those from Dudley, which often have the lobes as far apart as in Bohemian examples.

Affinities.—But one species, and of that only a caudal shield, has been described, which at all closely resembles this,—we allude to a species published without name by Dr. Beyrich, from Gottland, in his second paper (1846, pl. 1. fig. 9); it has the side lobes of the tail lengthened out into spines of some length. The terminal joint of the axis too is shorter. There is a second species in Britain, found at Haverfordwest, to which if it were perfect enough, a new name might be applied. It differs from *S. mirus* in this respect, that the large basal lobes of the glabella are more really tumid, especially outwards, less than their diameter apart, and connected with the body of the glabella by a narrow depressed neck on the inner side, the boundary furrow not completely circumscribing the lobe as in our species. But only a fragment of the head has yet been found, and I may say, that it is singularly like a fragment apparently of this genus lately discovered by Captain Strachey in the Silurian rocks of Tibet. There is a species figured by Sars in Oken's *Isis*, 1835, tab. 9. fig. 8, as the *Cal. clavifrons* of Dalman, which has a nearly globose glabella with the basal lobes very small; but it is probably a *Cheirurus*, and would, we think, be found to possess punctured cheeks.

History.—That Hisinger's figure of *Calym. clavifrons* does not represent the species so described by Dalman, though very probably, as Beyrich suggests, it may have been associated under the same name in his collection, has been shown by every author who has since written on the subject; and the great similarity between it and the species we are describing must be evident to all. Dr. Beyrich supposes it may be the head of the other species we have mentioned above from Gottland; but, as Hisinger's specimen came from Furdal in Dalecarlia, this is not certain, and we think we cannot be wrong in referring it to the present cosmopolitan species, of which it is a very good representation. Dr. Beyrich, when he formed the genus in 1845, had only the head and caudal shield, but these were sufficient to show him the generic distinctions, which we think are now confirmed by characters drawn from the hypostome and thorax rings, since figured by M. Corda and Barrande.

Professor M'Coy next described the head from Irish specimens, considering it a distinct species from the Bohemian one, but identical with that of Hisinger. His description is very clear, but having found among the Irish specimens considerable variation in the point he marks out as distinctive, viz., the breadth between the lower

lobes of the glabella, we have here ventured to unite them ;—the species agrees in all other essential characters. M. Corda in his *Prodromus*, 1847, next figured an outline of the entire animal and its hypostome, and Barrande's accurate figures complete the illustrations of this trilobite.

British Localities and Geological Range.—LLANDEILO FLAGS to WENLOCK LIMESTONE. In Lower Silurian, Chair of Kildare, county of Kildare, Ireland ; and in beds of the same age, Carrickadaggan, county of Wexford. In Wenlock strata, Dudley Castle Hill ; Trindle near Dudley ; Walsall (Survey Coll.)

Foreign Distribution.—In Bohemia ; Komorau, Hills of Listice, Kolednik, &c., in Etage E, Upper Silurian, and also in one of the "colonies" in the Lower Silurian, Etage D, (BARRANDE). In Sweden, Furudal, Dalecarlia ; in Lower Silurian (HISINGER). In North America, Springfield, Ohio, Upper Silurian. (De Verneuil and Sir C. Lyell.)

EXPLANATION OF PLATE III.

- Fig. 1. Coiled specimen from Dudley ; Mr. John Gray's collection.
 Fig. 2. The same specimen viewed sideways ; *a*, the terminal boss of the axis of the tail.
 Fig. 3. The head, dissected ; *a, a*, the strong basal glabella furrows ; *b*, the small eye ; *c*, termination of the facial suture in front of the posterior rounded angles ; *d*, the rudimentary cheek spine ; *e, e*, connecting portions of the free cheeks.
 Fig. 4. Front view of ditto ; *a*, is the middle glabella furrow ; *b*, the anterior one ; *c, c*, the free cheeks ; *d*, the connecting portion, here separated from the glabella along the line of the facial suture ; the dotted lines at *b* indicate the natural position in this view of the fixed cheeks, which are much bent down.
 Fig. 5. Free cheek, with the supinè eye (*a*) attached ; *b*, the fold of the crust which supports the eye, the "*palpebra inferior*" of some authors ; the surface of the cheek granulated equally all over.
 Fig. 6. Magnified portion of the eye ; *a*, upper surface, obscure in these specimens, but probably faceted ; *b*, lower surface, the lenses fallen out.
 (Figs. 3 to 6 also from Mr. Gray's collection).
 Fig. 7. Third or fourth thorax ring ; at *a*, the fulcrum, and *b*, the prominence against which the fulcrum of the succeeding segment abuts.
 Fig. 8. Last thorax segment, the fulcrum near the axis. In this and the preceding figure the pleuræ are represented as flattened out to show their characters ; they would appear much shorter on viewing them from above.
 Fig. 9. Tail ; at *a* the prominent tip of the axis is shown.
 Fig. 10. Part of thorax joint ; *a*, the axis magnified.
 Fig. 11. Basal lobes of the glabella, magnified to show the fine granulation that covers the whole head ; *a*, the deep circumscribing furrow.
 (Figs. 7 to 11 are taken from Mr. Fletcher's specimens, Dudley).
 Fig. 12. A group from Dudley, Mr. J. Gray's collection.
 Fig. 13. End view of the tail.
 Fig. 14. Head, from the limestone of Kildare ; it is a little elongated by pressure. Other specimens show a rounder form. [Survey collections.]
 Fig. 15. Tail, more elongated than in the Dudley specimens, also from Kildare.

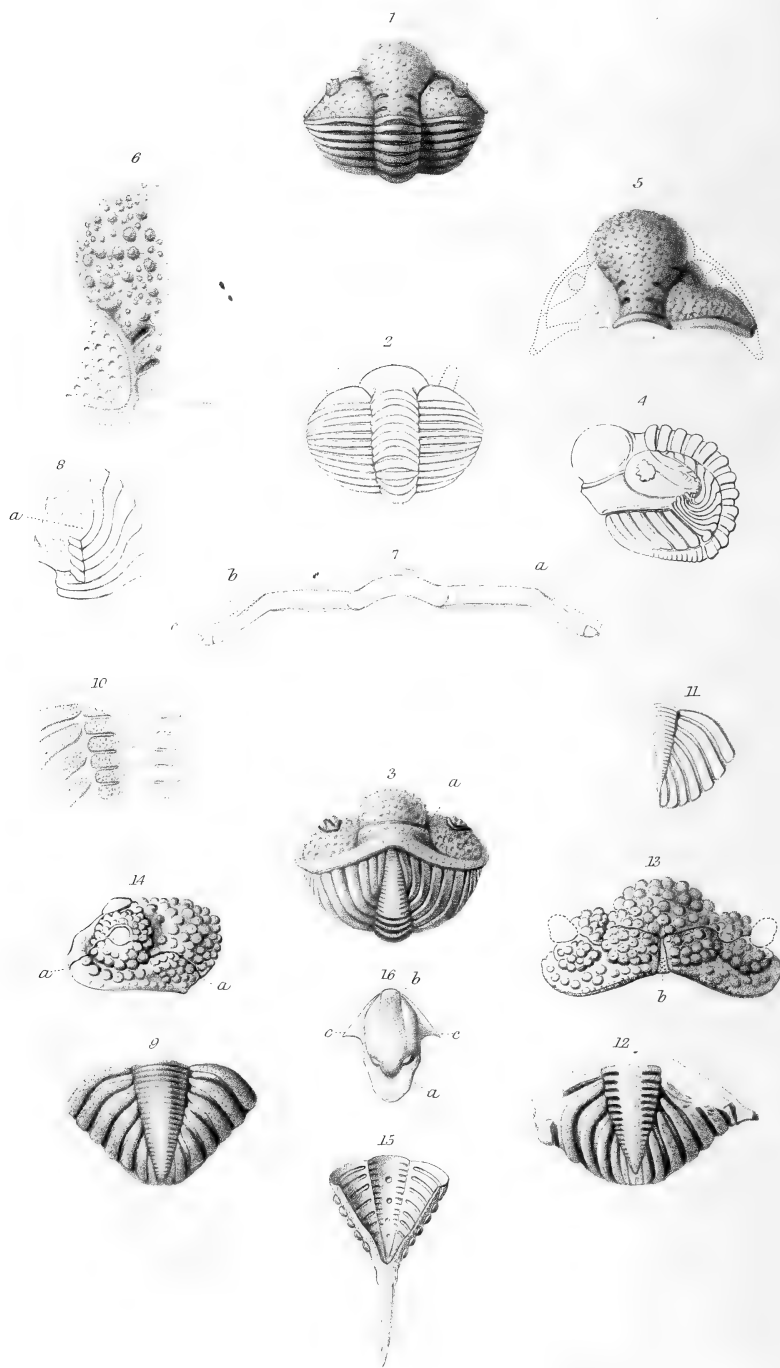
Remarks on the Genus.

When originally described by Beyrich, in 1845, he naturally included in this genus the species of *Cheirurus* with an inflated glabella, in which the anterior furrows are nearly obsolete, such as *C. sphaericus* of Esmark (which Sars described and figured as the *C. clavifrons*, Dalm.), and the true *C. clavifrons*, of which Lovén has since given so excellent a description. But the latter species has the nodular and furrowed thorax rings, spinose cheeks, and the long spined tail, characteristic of *Cheirurus*, so much so, that Dr. Beyrich asserts that portions of separate trilobites must have been combined in the description. We have, however, in England, as above described under Plate 2, the same or a very closely allied species, showing these characters, which we formerly described as *Sphæroxochus*, but now consider a true *Cheirurus*. The *Cheirurus globosus* of Barrande, and the *C. (Actinopeltis) Caroli Alexandri* of Corda, are examples of this section, to which for convenience sake, the sub-generic term *Actinopeltis* might be applied. [See *Cheirurus*, ante.]

J. W. SALTER.

August, 1853.





Figs. 1. 12. ENCRINURUS (*Emmerich*) } *Figs. 14. 13.* E. VARIOLARIS—*Brongniaart.*
SEX-COSTATUS—Salter. } *Figs. 15. 16.* E. PUNCTATUS—*Brünnich.*

BRITISH FOSSILS.

DECADE VII. PLATE IV.

ENCRINURUS SEXCOSTATUS. Figs. 1 to 1X.

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[Genus ENCRINURUS. EMMRICH. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadæ.) Glabella inflated, clavate, with 3 indistinct lateral lobes, and a large forehead lobe; eyes pedunculate, smooth (finely faceted, Kutörge); the facial suture posteriorly ends in advance of the head angles, and in front runs above the margin; the cheeks are separated in front by a vertical suture, enclosing a narrow vertical rostral shield; thorax segments 11, equal, without pleural grooves, notched at the ends, but not produced into spines; tail with the ends of the pleuræ free, the axis many ringed. *Εγκρινος* a lily-shaped animal; *ovpa* a tail, in allusion to the resemblance between the many-jointed axis of the tail and the stems of the Crinoidea.]

DIAGNOSIS. *E. latus*; glabellâ anticè subsphericâ et ad marginem frontalem fasciâ latâ crassâ circumcinctâ; genis scrobiculatis, angulis spinosis; caudâ trigonâ, obtusâ, axi annulis crebris, per medium (nonnullis anticis exceptis) obliteratedis; pleuris 6, rarius 7, subplanis.

SYNONYMS. *Cybele sexcostata*, SALTER (June 1848), *Memoirs Geol. Surv.*, vol. ii. pt. 1. pl. 8. fig. 10 (not fig. 9). *Zethus sexcostatus*, M'COY (1851), *Synops. Pal. Foss. Woodw. Mus.*, fasc. 1. 156. *Encrinurus sexcostatus*, SALTER (1852), *ib. Appendix A. vol. iv. pl. 1 g, fig. 6, 7.*

We are induced to figure this trilobite, although it is not quite perfect in all its parts, because it completes the illustration of the same species formerly given in the second volume of the *Memoirs*, where the tail only was figured; and it is the more desirable to present it in illustration of the genus, as the two species which are best known, the *E. punctatus*, and *variolaris*, are chiefly Upper Silurian, and have been fully illustrated lately in the "*Geological Journal*."

In the general appearance, in the structure of the remarkable elevated eyes and of the hypostome, the coarse tuberculation of the head,—the many-jointed axis of the tail, and its few lateral ribs, there is the greatest similarity to *Cybele*,* with which genus

* *Zethus* of Pander and Volborth, a name which we cannot adopt, because Pander's ill-defined genus was chiefly founded on a *Cheirurus*.

we have hitherto considered it identical, although there are 12 body rings to the latter, and only 11 in *Encrinurus*. But the delineations of the facial suture given by Drs. Volborth and Kutörge in the Transactions of the Royal Mineralogical Society of St. Petersburg, 1848, show that in this important particular, as well as in the number of body rings, the two genera differ; and when to this is added that the hinder segments of the thorax are not in *Encrinurus* produced into long spines but are all equal, we have a combination of characters sufficient to justify the separation. But there are species of *Cybele* whose habit is so like that of *Encrinurus*, that should a species hereafter be found with the facial suture of one of these groups, and the number of body rings distinctive of the other, we should recommend their reunion as sections of one natural genus.

Description.—Length about an inch and a half, breadth an inch. Some specimens must have been larger. General form broad-ovate; the head and tail convex, the body rather flat. Head about equal in length to the tail, but shorter than the thorax; its shape triangular, the lateral angles produced, the front rounded, gibbous, and overhanging. The glabella occupies full one third of the width of the head in front, where it is much inflated and more than hemispherical; it overhangs the margin, which, as is usual in the genus, is not distinctly separated from it in front, but within the margin and above it on the glabella, there is a strong furrow which runs quite across the glabella, separating from it a thick prominent ridge (fig. 3, *a*) so completely that it appears not to form a part of the glabella, but to belong to the thickened front margin.* The entire glabella is pyriform, constricted behind to half its width, and separated by a strong sulcus from the neck segment, which is broad and prominent. It is indented half-way up by three short furrows on each side. The cheeks, though convex, are much less so than the glabella, and they bear the eye in the middle of the cheek. In our specimen the eyes are broken off, but in all probability they were elongated, and directed forwards and outwards, as we have indicated by the dotted lines in our fig. 2. The outer margin of the cheek is thick, and separated by a furrow, and the posterior angles are produced into spines; the posterior edge also has the strong neck furrow continued along it. The glabella is covered with tubercles of unequal size, mixed with granules, but the specimen

* This singular furrow is probably the place of the facial suture, which in this genus crosses the front of the glabella. This suture is not visible in our specimens; but its course in front is well seen in *E. variolaris*, figs. 13 and 14, *a a*.

does not show whether these tubercles have each a pit on their summit; it is probable they are so constructed, like those of the other species in the genus. The raised fascia, too, in front, has so worn a surface that tubercles are not visible, if they ever existed. The cheeks, instead of being tuberculate, are pitted like those of *Cheirurus* or *Amphion*, and the raised interstices are covered with fine granules. The margins appear smooth, or only finely granular. We have no specimens of the hypostome, or indeed any part of the under surface of the animal.

The thorax consists of 11 segments; the axis moderately convex, of nearly equal breadth throughout, and considerably narrower than the pleuræ. These are quite horizontal as far as the fulcrum, which is placed more than half-way from the axis; and from this point they curve backward and downward to the tip, which is again a little bent forward, so that the line from the fulcrum outwards is a sigmoid curve; the hinder pleuræ curve less backward. Each pleura is nearly semicylindrical, with three or four tubercles along it, and there is little or no space anteriorly for the narrow flat rim which exists in the species of *Cybele*, and which we have called sometimes the fulcral portion.* We have not the extreme ends preserved; but from what has been observed in *E. punctatus* and *E. variolaris*, there is little doubt it was terminated by a bilobed tip, such as we have indicated by dots in fig. 7; the notch *c* being in front of the blunt outer tip, and indenting the end of the facet *b*. This faceted or flattened portion, which passes beneath the preceding ring in rolling, is shown in fig. 8, *a*.

Tail of a triangular form, wider by one third than the length, with an obtuse rounded apex, and flattened above, the sides and the tip deflected, so that the tail is moderately convex; the axis at the upper part is about one fourth the width of the tail, and tapers to a point at some little distance within the blunt apex; it is convex at its broadest end, and there the rings are continuous across, but from about the upper third it becomes flatter, and the rings are effaced along the middle; its apex is quite flat. There are about 20 rings in all, and no tubercles down the smooth central portion. The sides of the tail have six strong ribs, which are broad and somewhat flattened, divided from each other by narrow deep furrows, and have the tips squarish and obtuse. The ends of the

* In this genus, as in *Amphion*, *Acidaspis*, and some others, the pleura is not divided by a groove along its middle as it is in *Calymene*; the division into two parts, an anterior or fulcral portion and a posterior portion, exists, but the latter occupies nearly all the outer surface of the pleura.

four upper ones are free (or rather much overhanging the margin); the remaining two are distinct nearly as far as to the margin, but they there become fused with those from the opposite side, and extend in a very blunt point beyond the tip of the axis. The uppermost ribs arch strongly outwards, the next less so, and the last pair lie parallel to the axis.

On the internal cast, the furrows, especially those which bound the axial lobe, are all stronger and deeper, but there is no other difference. Externally the whole surface of the tail is covered with a close scabrosity (see fig. 10).

Variations.—In the cast from Sholes Hook (fig. 12) the rings on the axis of the tail are effaced down the middle for a broader space, and there are but few of the upper rings continuous across. Our figure in this case does not show the uppermost rings. There are sometimes (fig. 11) seven rings on each side of the tail.

Affinities.—When perfect specimens are obtained, there is no published species with which ours can be confounded. The sub-globular shape of the glabella, with its small tubercles, and the pitted, not tubercular cheeks, will easily distinguish imperfect portions of the head from all other British species. The separated tail, especially internal casts of it, may possibly be confounded with the same portion of *E. punctatus*, but the want of a central row of tubercles down the axis, and the arched lateral ribs, will enable observers to distinguish it. The other Lower Silurian British species, *E. multisegmentatus*, Portlock, is diametrically opposed in all its characters; it has a large coarsely tubercular head, and many-ribbed tail. Nor can the detached tail of our species be confounded with that of *Cybele verrucosa*, Dalman, so abundant in company with it, if the four tuberculate lateral ribs of that species be attended to. Ours has six or seven smooth ones.

History.—We first described this in 1848, in the work above referred to, under the name *Cybele seccostata*. In those figures there was associated with the tail, but only provisionally, a coarsely tubercular head, which occurred so frequently in company with it, that the two might reasonably be supposed to belong to each other. The figure we now give justifies the caution there expressed, for it is the "more clavate form of head rarely occurring," which properly belongs to the species; the head figured in company being, we are now all but certain, that of the *C. (Calym.) verrucosa*, Dalman, a species which we hope hereafter to illustrate as the British type of the genus *Cybele*, Lovén.

It had been previously described in manuscript for Professor Sedg-

wick's intended memoir on the fossils of Westmoreland and Wales ; and a short description of it will be found in the Appendix to the second fasciculus of his large work on the "British Palæozoic rocks ;" it is also described by Professor M'Coy, in the first fasciculus, as *Zethus sexcostatus*.

British Localities and Geological Range.—LLANDEILO FLAGS. Rhiwlas and Llwyn-y-ci, north-west of Bala Lake ; and Llechwedd Ddu, east of the lake, North Wales ; in the former locality very abundant ; Sholes Hook and Pelcombe Cross, Haverfordwest. Not yet found in Ireland.

EXPLANATION OF PLATE IV.

- Fig. 1. Coiled specimen ; from Rhiwlas.
 Fig. 2. Do. ; back view, to show the 11 thorax segments.
 Fig. 3. Do. ; showing the raised fascia *a*.
 Fig. 4. Do. ; side view.
 Fig. 5. Imperfect head ; the dotted lines are added from other specimens ; the cheeks show the pitted surface.
 Fig. 6. Magnified portion of head.
 Fig. 7. A thorax segment enlarged ; at *a*, the fulcral point ; *b*, the faceted surface, and *c*, the blunt indented tip, as usual in the genus ; they are added in dotted lines as the specimens are not perfect enough to show them.
 Fig. 8. Side view of the pleuræ in the coiled state ; at *a*, one of the faceted surfaces is seen by the breaking away of the other segments.
 Fig. 9. Tail of a Rhiwlas specimen.
 Fig. 10. Part of the same, magnified, to show the scabrous surface.
 Fig. 11. Variety of tail with 7 side ribs. Rhiwlas.
 Fig. 12. Internal cast of variety with the central part of the axis more free from ribs. Sholes Hook.
 Fig. 13. Front view of the head, slightly enlarged, of *E. variolaris*, to show the course of the facial suture in front of the head, and the vertical suture *b*, which divides the cheeks, filled at its lower end by a narrow triangular rostral shield. Wenlock limestone of Dormington, Woolhope.
 Fig. 14. The same, a side view ; *a a*, facial suture.
 Fig. 15. Under view, somewhat enlarged, of the tail of *E. punctatus*,* to show the incurved scabrous margin which unites the lateral ribs of the tail ; their free points are seen projecting beyond it. Walsall, near Dudley.
 Fig. 16. Hypostome of do., enlarged ; *a*, sinuated margin ; *b*, cucullate base ; *c*, the points of the extended base of attachment. Walsall.

The above figures are all from specimens in the collections of the Geol. Survey. The last four figures are enlarged to once and a half their natural size.

Notes on the other British species of the Genus.

If the strict rule of priority were observed, irrespective of clear definition, we should be compelled to adopt the name *Cryptonymus* for this genus, as that of *Zethus* for *Cybele*. Dr. Kutörge, indeed, in the journal above quoted (1848), advocates this course, and has

* See description at the end.

restored the name *Cryptonymus*, under which Eichwald at first described several varieties of the common *Asaphi* of the Russian Silurian Rocks. Subsequently, aware of his error, he restricted *Cryptonymus* to such trilobites as the *Calym. variolaris*, Brong., including the *C. punctatus*, and some forms of *Cybele*. But, though thus marking out the group he intended, he gave no description of the amended genus; besides which he was now applying the name to a totally different set of fossils to those for which it was originally intended. Under such circumstances it is impossible to retain his name in opposition to the genus clearly indicated, though not sufficiently described, in Emmerich's scientific arrangement, 1845. The latter name has been adopted, and the typical species fully characterized by Professor M'Coy (Synopsis Sil. Foss. Irel., 1846). The genus *Encrinurus* has a nearly universal range, being found in Silurian rocks from Russia to North America, and from the Arctic regions to Australia; and it has rather an extensive geological distribution, being found in Lower and Upper Silurian, and in the Devonian strata of Germany. *Cromus*, Barrande, a Bohemian fossil, is probably of the same genus; it has, however, four lateral lobes to the glabella, instead of three.

2. E. PUNCTATUS. Brünn. sp. Pl. 4. f. 14-16. 57

SYN. *Entomolithus paradoxus*, Linnæus, 1759, Act. Reg. Acad. Sc., Holm., p. 22. t. 1. f. 2. *Tril. punct.*, Brünn., Kjöbenh, Selsk. Skrivt. nye Samml. 1. 394. *Entomostrac. punct.*, Wahl. (1821), Act. Soc. Sc. Ups. v. viii. 32. t. 2. f. 1.—tail only. *Calym. variolaris*, Brongn., Crust. Foss., t. 1. f. 3 A. (not B.) *Cal. punctata*, Dalm. Pal. 47. t. 2. f. a, b. Murch. Sil. Syst. (1839), pl. 23. f. 8. *Phacops variolaris*, Emmrich. Diss. (1839), 20. *Asaph. tuberculatus*, Buckl. Bridgw. Tr., pl. 46. f. 6. *Encrinurus punct.*, Emmer. (1845), Neues Jahrb. 42. *Encrinurus Stokesii*, M'Coy (1846), Syn. Sil. Foss. Irel., t. 4. f. 15. Pal. Foss. Woodw. Mus. (1851), p. 158. *E. punctatus*, Corda (1847), Prodr. Tril. Böhm. 91. fig. 55. bona. *Cybele punct.*, Fletcher, Quart. Geol. Jour. (1850), vol. vi. pl. 32. f. 1-5.

E. ovatius, biuncialis; glabellâ clavatâ convexâ sed parum inflatâ tuberculosâ; tuberculis anticis paulo majoribus, in arcu dispositis, sulcis glabellaribus brevibus vix inter tuberculos magnos visis; genis convexis profunde marginatis, tuberculis sub oculo valde elevato angusto collocatis, angulis spinosis; hypostomate basi subcompresso, rostro apiculato; thorace axi pleuris curvatis paulo angustiore, segmento septimo decimoque brevi-spinosis; caudâ longe triangulatâ, lateribus ante apicem nunc planum recurvum, nunc deflexum obtusiorum contractis; costis lateralibus 8 obliquis, ad apices prominulis; axi nec convexo, annulis crebris per medium omnino oblitteratis, tuberculis quinque vel sex in serie longitudinali dispositis.

Var. a. Calcareus.—Caudâ in mucronem planum seu recurvum producto.

Var. b. Arenaceus.—Caudâ apice deflexo obtusiori.

The original Swedish species appears certainly to differ in no respect, so far as the tail is concerned, from that common in the Dudley limestone; the tubercles on the lateral ribs, on which so much stress has been laid, being always present, either at the origin of the rib or on its surface. And the species is pretty well represented by M. Corda from Swedish specimens. The thorax rings we have not seen from Sweden, but they are tuberculate as ours are, according to the figure above quoted.

The variety we have called *arenaceus* appears to differ only in the abrupt ending of the tail, which, instead of being horizontal and drawn out into a mucro of variable length, as in the limestone specimens from Dudley and elsewhere, is deflexed and blunt. But the specimens from the Caradoc and Llandelilo sandstones agree so well in all other particulars, the tubercles collected round the eye, the number of ribs and tubercles on the tail, &c. &c., that it cannot be separated as more than a variety. Its name indicates its usual habitats, and the deficient development of the tail may be connected with the deficient supply of calcareous matter. Upper Caradoc specimens are almost always smaller; occasionally, as at Bogmine, in Shropshire, they are of full size. Some Ludlow specimens have the glabella narrower, and but four tubercles down the axis of the tail.

Localities.—In Bala Rocks, Pwllheli, Carnarvonshire; Mathyrafal Wood, Montgomeryshire; also Westmoreland and South Wales. In Upper Caradoc Sandstone, var. β , May Hill and Tortworth, Gloucestershire, in great abundance, first observed at the latter place by T. Weaver, Esq.; Bogmine, Shelve; in the "Pentamerus Limestone" of the Hollies, and of Buildwas, Shropshire, abundant. In Wenlock Shale; Var. α , Woolhope. In Wenlock Limestone; Dudley, Walsall. In Upper Ludlow Rocks; Pilliards Barn, Woolhope. Ludlow Rocks of Marloes Bay, Pembrokeshire, var. β .

Foreign Localities.—Sweden, Norway, Russia, in Lower Silurian; Gottland, in Upper Silurian.

3. *E. variolaris*, *Pl. 4. f. 13, 14.* Brongn. sp. Λ , *Calymene*, BRONGN. (1822), Crust. Foss. t. 1. f. 3 B. (not A.) PARKINSON, Org. Rem., iii. pl. 17. f. 16. MURCHISON, Sil. Syst. (1839), pl. 14. f. 1. mala. (not of EMMR.) SALTER, Mem. Geol. Surv. (June 1848), vol. ii. p. 1. 344. FLETCHER, 1850, Quart. Geol. Journ., vol. vi. pl. 32. f. 6-10. *Zethus*, M'COY (1851), Pal. Foss. Woodw. Mus. p. 157.

E. ovatus, obtusus, sesquiuincialis, capite et thorace E. punctato simillimis, sed glabellâ inflatâ, nec anticè tuberculis in serie transverso dispositis, genis per totum tuberculatis, angulis rotundatis; hypostomate basi convexo; thorace axi inermi, pleuris rugoso-tuberculatis; caudâ convexâ brevi trigono, axi convexo pauci-annulato, annulis subæqualibus 9-12 interruptis et in tuberculos varie dispositos insectis, lateribus costis 7, deflexis, sæpe tuberculatis; apice abrupto deflexo.

Professor Burmeister in the supplement to his valuable work (ed. 2. p. 115), pointed out the obvious discrepancy between the two figures referred by Brongniart to his *Cal. variolaris*, and in a great measure set the synonyms right. But he was wrong in quoting the figures in the Bridgwater Treatise and Emmrich's description as for this species, which has obtuse and rounded, not spinose angles to the head. The characters of the tail are amply sufficient to separate the two common species; and I may add that those of the head, even if the angles are broken, are also well marked, the glabella of *E. variolaris* being inflated and equally clothed with large tubercles, whence the name "Strawberryheaded Trilobite;" while in *E. punctatus* it is convex, but not inflated, and in front has the tubercles distinctly gathered into a transverse series or crest, a character more marked in our next species. There should be no more confusion as to the names, since the publication of Mr. Fletcher's figures and description quoted above.

Localities.—Wenlock Limestone and Shale. Dormington Wood, Woolhope; Dudley and Walsall (abundant.)

4. *E. multisegmentatus*, Portl. sp. *Amphion*, Portlock, G. Rep., pl. 3. fig. 6 (too many side ribs.) *Ampyx baccatus*, id. (head), fig. 11. *E. multisegm.*, Emmr. (1845), Neues Jahrb., p. 43.

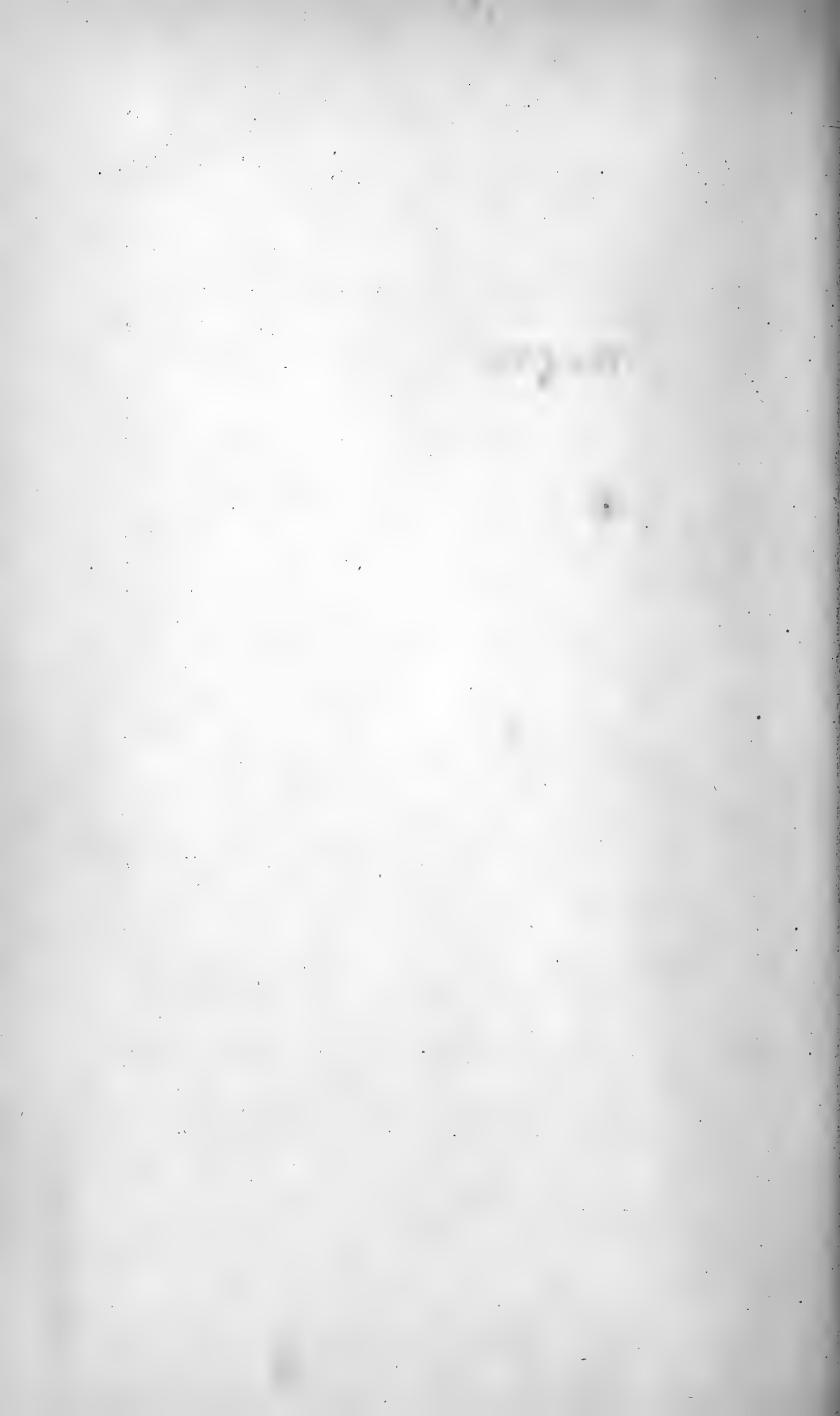
E. sesquiuincialis, depressus? glabellâ valde clavatâ, ad basin angustâ, tuberculosâ, a genis convexis profundè separatâ; tuberculis magnis anteriùs in cristam transversam arcuatam collocatis; genarum tuberculis (nisi duobus maximis), minoribus, caudâ longè triangulatâ, apice acuto nec producto deflexo, axi angusto annulis numerosis circiter 30, solum prope apicem oblitteratis; lateribus 12-costatis, costis arcuatis deflexis.

The crest of large tubercles, parted in the middle, along the front of the glabella, as well as the numerous ribs of the tail, are good marks of this elegant species. There can be no doubt the two portions above cited belong to each other.

Localities.—Lower Silurian [head and tail], Tyrone; Montgomeryshire [tail only].

J. W. SALTER.

August, 1853.





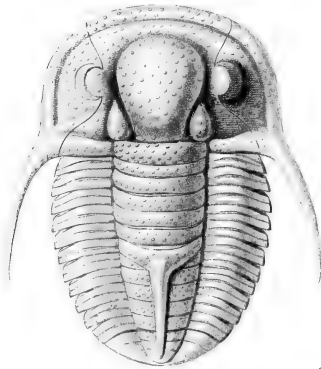
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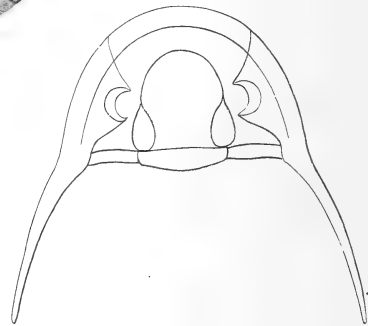
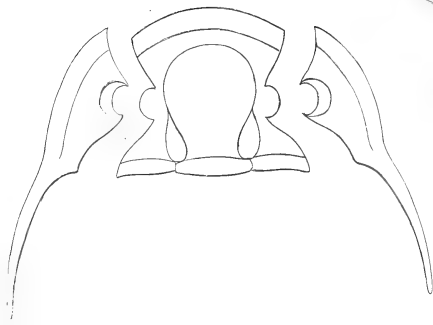


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3*



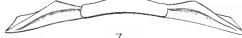
4
Glabella

5

a



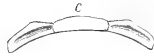
a



b



c



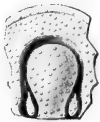
c



d



6



7



CYPHASPIS MEGALOPS — *M^c Coy.*

BRITISH FOSSILS.

DECADE VII. PLATE V.

CYPHASPIS MEGALOPS.

[Genus CYPHASPIS. BURMEISTER. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadæ.) Head tubercular, strongly margined; glabella very convex, resembling half an egg, much shorter than the head, without lobes, except a small basal pair which are longitudinal, oval, and deeply divided from the base of the glabella (and an obscure furrow above these on each side); cheeks very gibbous, the smooth eyes rising to a high level, without an ocular ridge; facial suture direct forwards to the margin from the eyes, and behind cutting the posterior margin near the angle, which is long-spinous; a small rostral shield present; thorax of 11 to 17 rings (or more?), the sixth joint of the axis frequently bearing a spine; pleuræ grooved; tail small, of few rings. *Κόφος*, a convexity; *ἄσπις*, a shield, in allusion to the inflated carapace.]

[Section *Cyphaspis*; glabella moderately large, thorax of 11 rings.]

DIAGNOSIS. *C. parvulus*; capite undique granuloso, fronte rotundato; glabellâ subhemisphericâ, nec gibbâ, oculos maximos vix supereminente; lobis posticis obovatis angustis; genis latitudine glabellam æquantibus; angulis longi-cornutis; limbo ante glabellam declivi angusto—vix margini incrassato latiori; thorace segmento sexto armato, spinâ crassâ appressâ caudæ apicem attingente; pleuris inermibus; caudâ lateribus unisulcatis.

SYNONYMS. *Harpes? megalops*, M'COY (1846), Synopsis Sil. Foss. Irel. pl. 4. fig. 5. *Harpidella megal.*, Ann. and Mag. Nat. Hist. (1849), vol. iv. 412.

We have figured, for the first time in Britain, a complete specimen, of this genus; it has been known for some years on the continent, and is one of those genera which are common to the Lower Silurian, Upper Silurian, and Devonian rocks, while it does not ascend into the carboniferous rocks.

Description.—One of the smallest known species of the genus; its length is never more than half an inch: the head, which is the widest part, is rather more than five sixteenths broad. The usual length is not above three eighths of an inch. General form convex and truly ovate, with the extremities obtuse. Head very convex and strongly granulose, in form about a semicircle, but contracted at the

posterior angles just in front of the strong curved spine, so that the sides are somewhat square. The spine is about equal in length to the head; it is directed first obliquely outwards and then curved a little towards the thorax again, reaching as far as to the 7th segment. The glabella is very convex, parallel sided or slightly parabolic if its whole contour be taken into account, but half egg-shaped if the small lateral lobes are excluded; it occupies about one third the width of the head, and extends forwards only about two thirds its length, a considerable though not very broad space being left between it and the thickened front margin. This space, together with the margin itself, about equals one third of the length of the glabella. Only one pair of lobes are present, which lie at the base of the glabella; they are convex, longitudinally ovate, narrow, each about one fifth the entire width of the glabella, and circumscribed by a deep sulcus, which divides them as much from the glabella as from the cheeks. These last are high-conical, and at about half-way up the head and near the glabella, bear the large, prominent, smooth eyes, which rise nearly to a level with the highest part of the glabella; a thick margin, continuous with the front margin, surrounds the cheek, and is separated from it by a strong sulcus, which does not quite reach the termination of the neck furrow; there is no abrupt hollow or any depression at the angle. The facial suture, contrary to its usual course in this genus, turns considerably outwards above the eye to cut the front margin—along which it runs; beneath the eye its course is abruptly outwards to the end of the posterior margin—a little within the base of the spine. The neck segment is tolerably broad and prominent, and the neck furrow deep and straight.

The thorax is much less convex than the head, and is always a little longer than it; it consists of 11 joints, with the axis moderately convex, tapering quickly backward, and of rather greater width than the pleuræ, especially at its anterior and posterior extremities; in front about equal to the width of the glabella. The 6th segment of the axis is greatly swelled and produced backwards, giving rise to a straight horizontal spine, which lies upon the surface of the posterior rings, and nearly reaches the end of the tail. Pleuræ short, flattish, divided nearly to the tip by a strong, straight groove, the fulcral portion being of the same width as the posterior half. The ends are thickened, truncate, and very faintly bilobed; the fulcrum is placed at about half-way along the pleuræ in the middle segments,—at a less distance posteriorly, and beyond it the forward edge of the pleura is sharpened or faceted for the purpose of rolling up. Tail small, transverse, and but slightly convex, much

less than half a circle, its entire width being but little more than that of the glabella; the axis is short conical, occupying one third its width, with one distinct ring, another more obscure, and a terminal joint; sides with one distinct upper furrow, which does not reach the margin.

All the prominent parts of the surface of the body are rough with small tubercles; but these are by far most evident on the glabella, cheeks, and neck segment; they are wider apart than their own diameter, and pretty regular in size.

Variations.—The forehead portion of the glabella in our figs. 3 and 3* is much smaller and less inflated than usual, giving the glabella a parabolic instead of sub-rectangular form; and the same variation is less conspicuous in fig. 7. In other respects they seem to be identical. Some Lower Silurian specimens have the space in front of the glabella a little wider than in those from Dudley, but even in Dudley specimens the anterior margin is sometimes narrower than this space and sometimes broader.

Sex.—Under the genus *Remopleurides*, described further on, at plate 8, the possible indication of sex by certain ornaments or appendages to the dorsal surface is adverted to. Of the small number of this species hitherto examined, we have met with no individuals destitute of the spine at the 6th segment, and it is therefore quite possible that it may be characteristic of the species, and not of one of its sexes. In the collection of Mr. Fletcher, of Dudley, one specimen (fig. 7) has the spine nearly double the ordinary length, or twice the length of the five anterior thorax rings. And this variation, which we can hardly help regarding as indicative of the male, is accompanied by a less inflated glabella, the basal lobes being set more widely apart, as above mentioned, and by a somewhat more pointed form of the head. In *C. Burmeisteri*, the large Bohemian species, the curved dorsal spine always occurs on the same 6th segment, and is always long.* But it is at least worthy of remark that the possession of such a dorsal spine is characteristic of the male of some of the *Cymothoadae*, a group of Isopod crustacea very analagous, though probably not closely allied to, the Trilobites. In the genus *Sphaeroma*, the male of one species, *S. diadema*, is characterized by the presence of a spine very much like that of *Cyphaspis*, and occurring too on the 6th thoracic segment; in the

* In *Encrinurus punctatus*, described above, pl. 4, such spines, but much shorter, occur on the 7th and 10th segment; and there are certain trilobites, *Sao hirsuta* and *Bronteus spinifer*, Barrande, for example, that have a prominent spine on every thorax ring: so that we must estimate this character at no more than its proper value.

female of that species, a rudimentary spine or tubercle is all that occurs. Several others are described, *S. armata*, &c., distinguished by such an appendage; it may perhaps be proved that some of these are males of the unarmed species.

Affinities.—As nearly all the known species are double the size of this, a close comparison is not necessary; and *Cyphaspis Burmeisteri*, Barr., besides its very much larger size, has 7 to 15 thorax rings according to its age, and the tail with five rings to the axis; the space, too, between the glabella and front margin is very wide: the posterior head spines short, reaching only to the 4th ring. Like our species, it bears a spine on the 6th thoracic segment. *C. Barrandei*, Corda (the species called formerly, with doubt, *C. clavifrons*, by Barrande) has 11 rings, but the glabella is vastly more inflated and the head margin narrow; the posterior head spines, too, are one and a half times the length of the body. *C. cerberus*, of the same author, has the head fringed with spines; and the Devonian species, *C. ceratophthalma*, Goldf., besides its greater bulk and much more convex head, has a scrobicula or pit at each of the posterior head angles. The pretty Swedish species, *C. elegantulus* (*Proetus eleg.*, Angelin), is more like ours, but has an elongate head and 12 unarmed thorax rings. In fact there is no published fossil which can be confounded with it.

The genus is more rich in species than might be supposed, but they have only been discovered of late years. *C. ceratophthalma*, Goldf., of the Eifel, furnished Professor Burmeister with the type, which he described in 1842, in his original work; since which time Barrande, Lovén, and Sandberger have made us acquainted each with a few species. M. Corda has largely swelled the list, dividing the genus into *Goniopleura*, with 12 rings, *Cyphaspis*, with 11, and *Conoparia*, with 13; but the differences he notices are by no means sufficient for the establishment of distinct genera, though possibly the species with a very wide space in front of the glabella, and with more than 11 body rings, may form a subgenus. Now that we possess the work of M. Barrande, who has discovered the several species with great variations in the number of thorax rings according to their age, (in *C. Burmeisteri*, from 7 to 15), the limits of these sub-genera may perhaps be arrived at. Our species, at all events, will fall into the same group of 11-ringed species, with that originally described by Burmeister.

History.—Abundant but very imperfect specimens of the head of this little trilobite were detected by Professor M'Coy, and carefully described by him in his account of the Irish Silurian

fossils. His specimens were not perfect enough to enable him to see the true position of the large eyes on the head, nor the strong granulation of the glabella, and he referred it therefore, with a doubt, to the genus *Harpes*, suggesting that it might form a new group allied to that genus; this idea was carried out in his classification of the British Trilobites, in the Annals of Natural History, for December 1849, in which this trilobite stands as the type of a proposed new genus, *Harpidella*, and the granulated surface is mentioned. In a communication from him lately, he is agreed with me in identifying these perfect specimens with those described by himself. It is mentioned by myself, Proceed. Brit. Assoc., 1852, Sect. p. 57.

British Localities and Geological Range.—LLANDEILO FLAGS to LOWER LUDLOW ROCK. In Llandeilo flags; sandstones of Ardaun, Boocaun, Cappacorogue, and Tonlegee, Cong, county of Galway (Mr. Griffiths' collection); limestone of Portrane, county of Dublin; sandstones of Mullock quarry, near Girvan, Ayrshire (M'Coy); Bala limestone of Cader Dinmael, near Corwen, North Wales; in the Wenlock limestone and shales of Dudley and its neighbourhood (figs. 2-6); in the Wenlock shale, west of the Worcester Beacon, Malvern Hills; Lower Ludlow rock, of Hole Farm, near Philsley Beauchamp, Abberley Hills (fig. 1). [Survey Collection].

EXPLANATION OF THE PLATE.

- Fig. 1. A nearly perfect specimen, from the Lower Ludlow Rock, Abberley; natural size.
- Fig. 1*. The same, enlarged. The tail in this figure is rather too large, both as to length and breadth.
- Fig. 2. A fine specimen from Dudley, in the collection of T. W. Fletcher, Esq.
- Fig. 2*. The head, magnified, and dissected at the suture. The glabella and its basal lobes are in this of the usual form.
- Fig. 3. A variety from Dudley (Mr. Gray's coll.), in which the glabella is shorter and more parabolic in outline; it is a rare variation.
- Fig. 3*. The same, magnified.
- Fig. 4. A fragment from Dudley, placed laterally in the rock, and showing the dorsal spine parallel to the body, and reaching to the tail. (Mr. Gray's cabinet.)
- Fig. 5. Magnified dissections of the thorax; *a*, the anterior segment, with its pleuræ obliquely truncate at their ends; *b*, the 6th segment, showing the broad deep pleural groove and the long dorsal spine; *c*, the last or 11th segment; *e*, the small transverse tail.
- Fig. 6. A lateral view of the head, magnified.
- Fig. 7. A specimen, from Dudley, with the dorsal spine greatly elongated. Natural size, and enlarged. (Mr. Fletcher's coll.)
- Fig. 8. A head from Cader Dinmael, Denbighshire; Bala limestone. Natural size, and enlarged.

Other British Species.

Only one other certain species of the genus has yet occurred in England, and that so like the *C. (Proetus) elegantulus* from Gottland, that if it were not for some differences in proportion, long head spines, &c., it would have been thought the young of that species. Its characters may be thus given :—

C. pygmaeus, sp. nov. [*Proetus elegantulus*, Angelin (1852), Palæontol. Suec., t. 17. fig. 7. Lovén (1845), Ofvers. Kongl. Vetensk. Akad., t. 1. fig. 4. *junior*?]

C. minutus, ovatus; capite granuloso fronte paullum producto; glabella depressâ genis angustiori, lobis basalibus rotundatis; oculis parvis; limbo antico angusto tumido, angulis posticis longispinosis; thorace segmentis 12, axi angusto, pleuris acuminatis—posticis recurvatis, fulcro anticè ultra dimidium posito; caudâ minutâ, lateribus costatis.

Not two lines long, (while *C. elegantulus* grows to an inch and a half,) depressed, the head rather more than one third the entire length; glabella round oval, the small basal lobes full twice their diameter from each other. A narrow and tumid space lies between the glabella and the somewhat produced and narrow front border. The cheeks are considerably wider than the glabella, and bear the small eyes at a short distance from the latter; their angles are produced into long divergent spines, which reach as far as to the 7th or 8th thorax segment. The pleuræ are wider than the axis, and have in front the fulcrum very remote, behind it is not quite one third away from the axis. The tail is very small, the axis and sides are ribbed, but it is too imperfect to be described properly.

The characters above mentioned may be those of a young specimen; but it has the full number of rings, and in this genus they increase in number with age; the head is not nearly so produced in front, nor the glabella so convex as in *C. elegantulus*, and the head spines are proportionally much longer; above all, the Gottland species has blunt pleuræ, and in ours they are decidedly acuminate, the hinder ones being even recurved at the tips; the pleuræ are grooved nearly to the ends.

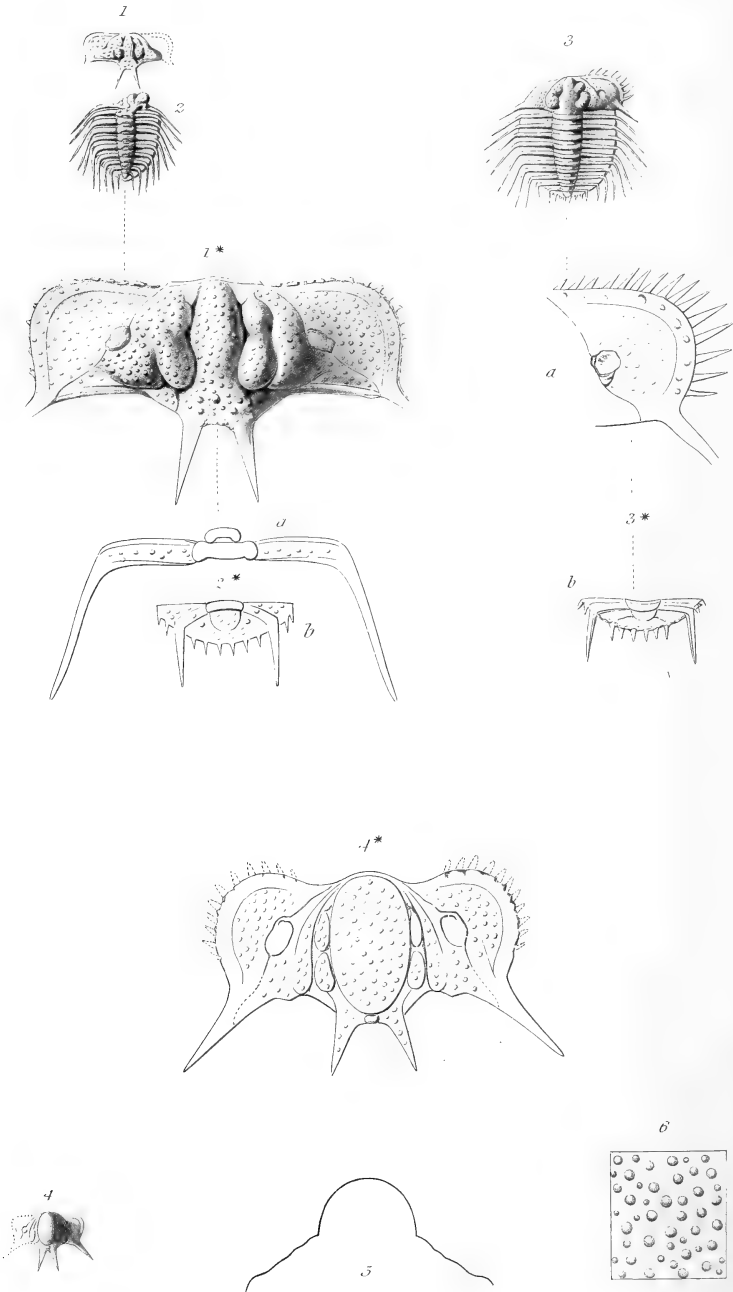
Locality.—Eastnor Castle, Malvern Hills; in Wenlock shale.

J. W. SALTER.

August, 1853.







1-3 ACIDASPIIS JAMESII . Salter.

4-6 ACIDASPIIS BISPINOSUS M. Coy.

BRITISH FOSSILS.

DECADE VII. PLATE VI. Fig. 1, 2, 3.

ACIDASPIS JAMESII.

[Genus ACIDASPIS. MURCHISON. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadaæ.) Capable of rolling up, or even contractile into a ball. Head short, broad, truncate in front; the glabella broadest at the base, with a median portion strongly separated from the three lateral lobes, which are obscurely divided from the cheeks (and often connate with them); cheeks thickened, generally spinose at the margin, and with the angle produced into a spine; eyes smooth, convex, (occasionally elevated on a long peduncle) connected with the front of the glabella by a strong ocular ridge; neck segment much enlarged, and generally produced into spines; body of 9 or 10 segments (fewer during the metamorphosis), with a narrow convex axis, and horizontal pleuræ which are produced at their ends into spines; tail small, axis abbreviated, limb multidentate, with one strong lateral rib on each side produced beyond the margin. *axis*, mucro; *aspiris*, scutum.]

DIAGNOSIS. *A. latus*, depressus, granulosus; capite haud convexo, glabellâ triangulari, utrinque lobis duobus ovatis à genâ dilatata fere distinctis—tertio obscuro; oculis medianis; jugo oculari obscuro; angulis brevispinosis; thorace segmentis 9 unispinosis, caudâ spinis 12, primariis fortibus parallelis, reliquis minutis,—terminalibus sex, externis utrinque duobus.

SYNONYMS. *Acidaspis bispinosus* (M'COY), SALTER (June 1848), Memoirs Geol. Surv., vol. ii. pt. 1. pl. 9. fig. 5 (not f. 4.) *Acid. Jamesii*, id. (1852), Proceed. Brit. Assoc., p. 57.

We have now sufficient materials to illustrate completely an *Acidaspis* from the Lower Silurian rocks; they are very rare in these formations in Britain, nor are they characteristic of them in other countries, although they are plentiful in the Upper divisions.

The honour of first distinguishing this most remarkable genus is divided between Dr. Emrich and Sir Roderick I. Murchison; the former having fully characterized the genus* but a very short time after the publication of the "Silurian System," in which the complete head of the more common Wenlock species was figured, and a new genus proposed to mark its peculiarities.

* De Trilob. Dissert. inauguralis (1839), 53, Berlin.

Of all the extravagant forms of this curious family of trilobites, none seems so extravagant in its ornament as the genus *Acidaspis*; the head, thorax, and tail being literally crowded with spines wherever an available angle occurs. The neck segment is produced into 1, 2, 3, or even 8 spines. In the thorax, the segments of the axis have sometimes two long spines on each, and the pleuræ have spines on their surface, and frequently two, or even three at the extremity; the tail is found with from six to 25 of these projections, and the margin of the head is generally furnished with a spiny fringe; to this last character there are but few parallels in the whole family (it occurs in *Staurocephalus*, *Calymene*, and *Cyphaspis*); and it may be compared with the perforated fringe of *Trinucleus*, or contrasted with the long frontal spine of *Ampyx*. Yet, in some respects, *Acidaspis* resembles *Lichas* (a genus not yet illustrated in these Decades) in the deep separation of the side lobes from the rest of the glabella, and their frequent fusion with the lateral parts of the head; here, too, as in *Lichas*, the facial suture cuts the posterior margin of the head. The tail also is composed of but few segments, as indicated by the joints of the axis, for the number of spines on the lateral parts probably do not indicate half the same number of real segments.

Dr. Emrich, who wished to show that all trilobites had nearly the same number of body rings—about 20 or 21—noticed that his genus *Odontopleura* possessed a much fewer number than trilobites in general; and he proposed to consider the thorax segment as compounded of two, the free joints of which were exhibited at the ends of the pleuræ. This, however, is not now tenable, for we have seen some species, which on this view would consist of 40 segments, taking the body and tail both into account. It is quite certain that the anterior and posterior divisions of the pleura are both extended, and this character is peculiar to *Acidaspis*, and to some only of the species. Barrande has shown that the segments of the thorax increase in number with age. The genus is found both in Lower and Upper Silurian, and in Devonian strata.

Description.—General form broad and depressed, the surface granulose, the edge fringed with radiating spines. The length, exclusive of the spines, is eight lines, and the breadth six lines. The head is widely transverse, three times as broad as long, and with the front and back edges parallel; the cheeks obtuse, squarish at the upper angles, or even overhanging, and fringed with about 16 spines, which increase in size towards the outer margin; below these there is an abrupt contraction, followed by a widely divergent

spine, which is much shorter than the width of the cheek. The eye is placed midway up the head, a little in advance of the greatest convexity of the cheek, and at one third outwards from the glabella, with which it is connected by a very slightly prominent ocular ridge (perhaps stronger when the crust is perfect). The facial suture appears to run along with this ridge forward, and behind the eye it takes an outward direction and cuts the posterior margin just under the base of the angle spine. The neck furrow is very strong, and is overhung by the gibbous inner base of the cheek.

Glabella broadly triangular, not very convex, with a distinct median lobe and two pairs of round lateral lobes, besides a third upper pair, which are small and not distinctly separated from the cheeks. The basal lateral lobes of the cheeks are equal to the median lobe in width, and are well separated from the most convex portion of the cheeks; above they are fused with them, as is also the upper or second lobe on its outer edge, but both of these lobes are circumscribed above and below, and on their inner edges by deep furrows; the glabella appears on the whole to be quite distinct from the cheek. The neck segment is not cut off by any distinct furrow; it is convex, expanded backwards, and produced into two somewhat divergent spines, about equal in length to the glabella. The front of the head is truncate, and its middle portion as usual free from spines. Surface of the head covered with large and small granules, set thickest on the glabella and gibbous base of the cheeks.

Thorax horizontal, except the very convex axis which occupies rather more than a quarter its width; of 9 segments, which are each semi-cylindrical (*plèvre d bourrelet*, Barrande), and ornamented with granules (fig. 2). They terminate in a strong spine equal in length to the pleura, and bent backwards at right angles to it on the hinder segments; in the forward ones the spines are shorter, and set at an obtuse angle. When the interior cast of the thorax is examined (fig. 3), the pleuræ are not seen as semi-cylindrical, but much flatter, and a broad raised ridge runs obliquely along their upper border, leaving a flat space behind. This is, of course, due to the different thickness of the crust at different points.

Tail minute, semicircular, with a small, narrow, and convex axis of two joints, the limb flat, except the convex ridge which runs obliquely from the axis to the primary spine on each side. These spines are directed backwards, parallel to each other, and extend nearly as far as those which run out from the last of the body segments. Between these are six small equal marginal spines, and a pair of similar spines outside the large ones on each side of the tail.

Scattered granules, like those on the head, are sparingly distributed over the more convex parts of the body rings, and occur both on the axis and sides of the tail (fig. 2*). The spines are all smooth.

Variations.—We have only three specimens, and between our figs. 1 and 2, and fig. 3, the only differences seem to arise from the greater pressure to which the latter has been subjected. In fig. 3, preserved in soft black slate, the axis is widened and depressed, the pleuræ less convex, and their spines more divergent, and the glabella is somewhat widened and deeply furrowed. In addition, the cheek margin appears to overhang more, and to be contracted much more decidedly above the spine. The terminal spines of the tail, too, are rather more crowded.

Affinities.—Except with the species next described, and with which I formerly united it, there is no British fossil which has any near resemblance. Among foreign species, *A. mira*, Barrande, has a pair of neck spines, but has the eyes far backwards, and is a true *Acidaspis*; *A. Prevosti* and *A. Dufrenoyi*, Barrande, which belong, perhaps, to the same section with *A. Jamesii*, have but four terminal and two extremely long primary spines to the tail; and *A. Verneuilii* and *A. vesiculosa*, which belong to the section *Trapelocera*, and possess each two neck spines, have the eyes remote, as in the Wenlock species quoted in our next description.

Locality and Geological Position.—LLANDEILO FLAGS. Fig. 1, 2, from the sandy schists of Newtown, Waterford. Fig. 3 is in black slate, Duncannon, Wexford. (Mus. Geol. Survey, collected by Capt. James, R.E.)

ACIDASPIS BISPINOSUS.

DECADE VII. PLATE VI. Fig. 4.

DIAGNOSIS. *A. capite convexissimo, glabella lobo mediano ovali gibbo per totum capitis extenso, lobis lateralibus utrinque tribus minutis linearibus; oculis ante medium genarum positis; cervice bispinoso.*

SYNONYMS. *A. bispinosus*, M'COY (1846), Synopsis Sil. Foss. Ireland, pl. 4. fig. 7. (not *Odontopleura bispinosa*, EMMERICH, 1845), see M'COY, l. c.

The head only of this species is known, and it is remarkable for the extreme gibbosity of the central lobe. Our specimens are about four lines wide; the one figured by Professor M'COY is double that size.

Head scarcely thrice as wide as long, and the convexity equal to three fourths the length. The glabella extends nearly the whole

length of the head; it is narrow, oval, and nearly all occupied by the swelled central lobe, the two linear oval lateral lobes on each side, and a minute upper third one, only skirting the base of the large central one, and not indenting its sides, as they do in most other species. In front, this protuberant lobe pushes forward the anterior margin and makes it sinuous, and behind it is immediately succeeded by the two short diverging neck spines (with a small tubercle between them), no space being left for a large neck segment. The cheeks are roundish, rather convex, and steeply bent downwards, as shown in our lowest figure, which is a section of the head; they have a thickish border separated by a strong furrow, and studded on the edge by several small spines, and they are enlarged outwards so as to overhang the base of the stout spine which occupies the posterior angle. Between the projecting anterior margin of the cheeks and the equally projecting front, the border is depressed on each side of the glabella, so as to form a hollow curve in which the facial suture terminates. The posterior margin of the cheeks is uneven, and shows a slightly impressed neck furrow. The eyes are apparently large and prominent, with a tubercular eye lobe, and are placed full half-way up the cheek, and about half-way outward, or rather more, from the convex lobe of the glabella. Between the eye and the small glabella lobes, and parallel to the latter, the space is filled up by a longitudinal swelling or lobe, rising above the surface of the cheek, but fused with it towards its prominent base. An oblique ridge below the eye connects that organ with the stout widely diverging cheek spine, and along this ridge the facial suture runs, and is supposed to terminate just within the base of the spine, but the head could not have been separated at the facial sutures. Coarse tubercles, with a few finer ones, cover the whole of the head except the shallow furrows; they are not, however, distinct on the cheek border, nor on the ocular ridges.

Affinities.—Now that we have a perfect head of this species, there is no other with which it could be confounded. The figure given by Professor M'Coy, cited above, is quite correct, but it was from a very fragmentary specimen, and both he and myself regarded the first found specimens of *A. Jamesii* as identical with it. That species, however, as contrasted with small and more perfect specimens we now possess, differs by its depressed form, and by its lobed glabella, with the median lobe moderate as compared with the side ones. In this species it is monstrously developed at the expense of the others, which are reduced to mere rudiments. The eyes, too, lie more outwards and forwards, and in this as well as the gibbosity

of the head, a nearer approach is made to the typical species of the section *Trapelocera*.

The common two-spined Wenlock species (most inadvertently connected with it in the "Memoirs Geol. Surv.," vol. ii. pt. 1. pl. 9. fig. 4) has much more remote eyes, and the glabella lobes quite fused externally with the cheeks. It probably belongs to the same section with those now described, and if not identical with the *A. (Trapelocera) vesiculosa*, Beyrich, is very closely allied to it. Mr. Fletcher, of Dudley, has named it *A. Barrantii*, and will publish it shortly. It must form the subject of a future plate, as it is the type of the sub-genus *Trapelocera*.

Professor M'Coy, in his work, has shown that this has nothing in common with the *Od. bispinosa*, Emmer, a name proposed by him to be substituted for *O. ovata*, by which he formerly (Dissertation Inauguralis, 1839,) designated his species; the name in that case refers to the double spinous terminations of the pleuræ, not to the projections from the neck, which appears to be smooth and unarmed.

British Locality and Geological Position.—LLANDEILO FLAGS: In the limestone of the Chair of Kildare, county of Kildare, which, by its numerous fossils, is exactly referable to the age of that of Llandeilo and Bala. [Coll. Geol. Survey.]

EXPLANATION OF PLATE VI.

Fig. 1. Head of *Acidaspis Jamesii*, natural size. Newtown, Waterford.

Fig. 1*. The same magnified.

Fig. 2. Body; shows also portion of the head. Same locality.

Fig. 2*. Portions of the same, magnified; *a*, external surface of one of the thorax rings; and *b*, the 12-spined tail.

Fig. 3. Interior cast of another specimen from the slates of Wexford. This specimen is the same as that figured Mem. Geol. Survey, vol. ii. pt. 1. pl. 9. f. 5.

Fig. 3*. Shows portions of the same, magnified; *a*, the cheek with its spines; *b*, the tail with its marginal spines.

Fig. 4. *Acidaspis bispinosus*, M'Coy, nat. size. Chair of Kildare. [Survey Coll.]:

Fig. 4*. The same, magnified.

Fig. 5. Section of the gibbous head.

Fig. 6. Tubercles and granules of the surface, highly magnified.

Notice of one or two other British Species.

3. There is a species found in the Bala Limestone, of which we have only a portion of the head. It differs from *A. Jamesii* in having fewer and larger tubercles on the head, and the central glabella lobe broader in proportion to the side lobes; it is too imperfect to name.

4. The head of a small species, about equal in size to our figured specimens of *A. bispinosus*, occurs with it very rarely in the Chair of Kildare, Ireland. The central glabella

lobe is very large, and the lateral ones minute and pressed against the sides, as in that species, but the former is parallel-sided instead of oval, not nearly so convex, and instead of being covered equally with small tubercles, is studded with a double row, five on each side and a terminal one, of large boss-like ones, between which the surface is finely granulated. Similar large tubercles occur on the space between the glabella and the forward eyes, and even on the front margin. If it were more complete (we have only the central part of the head without the cheeks), it might be called *A. biserialis*.

5. There is a narrow transverse caudal shield, also from the Chair of Kildare, the hinder margin of which is closely serrated by 19 long spines, the primaries being not much longer than the others. It resembles *A. radiata*, Goldfuss.

Lastly in the Llandeilo or Bala rocks ("Caradoc sandstone") of Shropshire, a small and pretty species, half an inch long, occurs. It has six terminal spines to the tail, as in *A. Jamesii*, but the primaries are more divergent, as are the spines of the thorax. The head has longer spines at the angles, and the glabella is truly triangular and very distinct from the cheeks, the lowest lobes much larger than the second, and the uppermost quite obscure. The eyes are more backward and the cheeks much smaller. We may define it thus:—

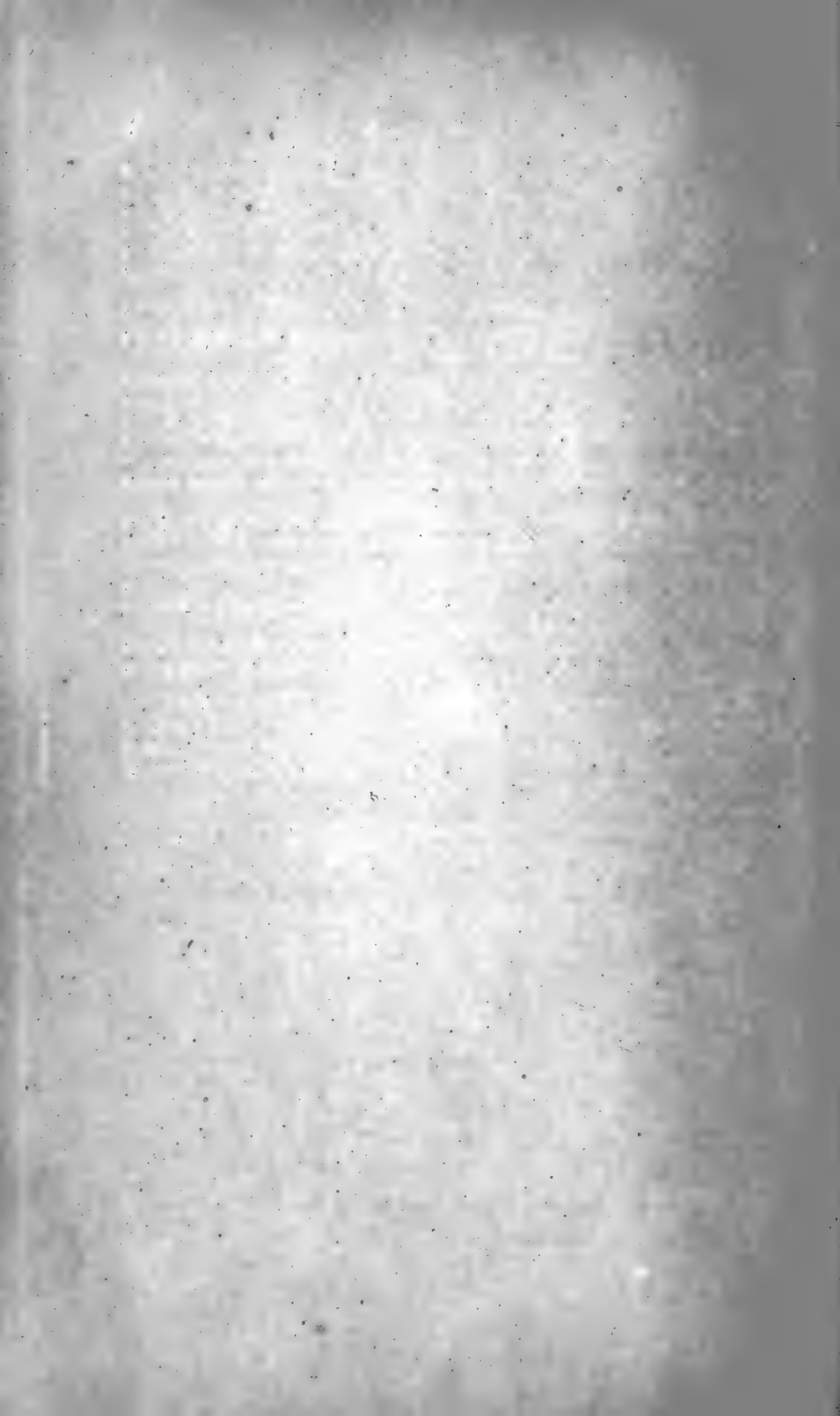
6. *A. Caractaci*, sp. nov. *A. semiuncialis*, capite semilunari convexo, glabellâ late triangulatâ, tuberculatâ, a genis convexis bene distinctâ, utrinque bilobatâ; lobo basali centalem æquante rotundo circumscripto, quam secundo duplo latiore, hoc distinctissimo obovato: superiori obsoleto: [cervice—?] thorace axi convexo, pleuris ad apices deflexis bispinosis, caudâ 12 (vel 14?) dentatâ, spinis primariis fortibus paullum divaricatis, terminalibus minutis 6, externis 2 (vel 3); axi convexo.

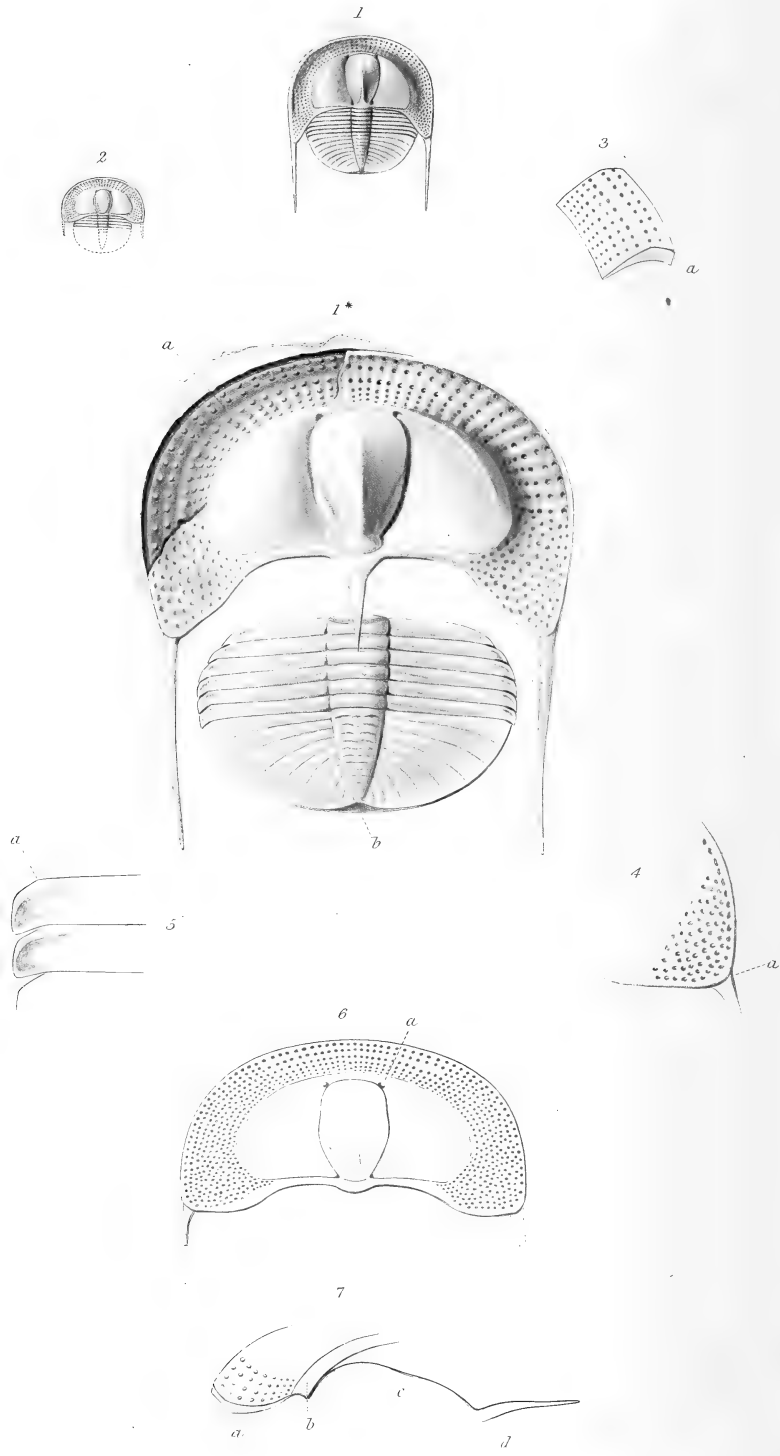
Locality.—Gretton quarry, near Cardington; a locality rich in all the characteristic Bala species. *Lichas laxatus*, *Phacops conophthalmus*, and *P. truncato-caudatus*, *Calymene Blumenbachii*, *Illænus*, &c. occur with it.

The species which is to be considered the true type in Britain of the section *Acidaspis* proper, is the *A. Brightii*, Murchison, which we hope, with the assistance of our friends at Dudley, to publish hereafter. Several British species will then be enumerated as belonging to that section, and among them a new species, *A. coronatus*, Salter, formerly called *A. Brightii* (Mem. Geol. Surv., l. c. pl. 9. f. 8. 9.)

J. W. SALTER.

August, 1853.





TRINUCLEUS ILOYDII—Murchison.

BRITISH FOSSILS.

DECADE VII. PLATE VII.

TRINUCLEUS LLOYDII.

[Genus TRINUCLEUS* (Llhwyd) MURCHISON. (Sub-kingdom Articulata. Class Crustacea. Tribe Trilobitæ.) Head of one piece, the facial sutures being soldered; the margin expanded into a hollow fringe, with several rows of perforations; eyes minute, sometimes absent; hypostome convex, elongated, without furrows. [BARR.]; body six-ringed, fewer, 0-6, during the metamorphosis. CRYPTOLITHUS, Green.]

[Sub-genus *Trinucleus*. Eye line and ocular tubercle obscure; glabella lobes indistinct.]

DIAGNOSIS. *T. rotundus planus, testâ tenui; glabellâ pyriformi abbreviatâ nec genas excedente, subcarinatâ; cervice spinifero; fimbriâ marginali concavâ, punctis minutis radiatis crebris in ordines 6 concentricos collocatis; alis magnis triangulatis, caudam attingentibus, spinis longis parallelis [nunc truncatis inermibus?]; caudâ concavâ truncatâ, sulcis lateralibus.*

SYNONYMS. *Trinucleus Lloydii*, MURCHISON (1839), Silurian System, tab. 23. fig. 4. EMMRICH (1839), Dissert., p. 53. MILNE EDW. (1840), Crust., vol. iii. 331. *T. granulatus* (Wahl.), BURMEISTER, Trilob. (1843), 66; 2d ed. (1846), p. 57. SALTER (July 1847), Quart. Geol. Journal, p. 254. PHILLIPS and SALTER (June 1848), Memoirs Geol. Surv., vol. ii. pt. 1. p. 240.

VAR. β . *Corndensis*.—*angulis posticis capitis brevioribus*, figs. 2 and 6.

This elegant species is abundant in Carmarthenshire and in the mining district of Shropshire, the only localities in which it has yet been observed; for although it has been supposed identical with a species common in Sweden, it is apparently quite distinct, and it is here figured as well to clear up this point, as because it is an excellent illustration of the remarkable genus to which it belongs.

Description.—Length about three quarters of an inch, and width one inch. General form flattish, especially behind,—circular, or, excluding the fringe, a very broad oval, and with long spines directed straight backwards and reaching far beyond the tail.

* From *tres*, three, and *nucleus*, in allusion to the three convex portions of which the head is composed.

Head occupying more than half the entire length, and forming a semicircle, exclusive of the long depending ears which reach to about the middle of the tail. The glabella is pyriform, moderately convex, not equal in width to the cheeks, nor reaching quite to the fringed border in front, but separated from it by a narrow convex space (fig. 7, *b*). In the strong furrow which surrounds the glabella, and at the anterior part, in a line with its front edge, are placed the two deep indentations characteristic of the genus * (fig. 6, *a*). The glabella is carinate along its lower half; it has on each side a slight longitudinal depression, and at its very narrow base one obscure lateral sulcus above the neck furrow. The neck lobe is produced into a rather strong spine, with a broad base. Neck furrow shallow, continued along the posterior edge of the cheek, which is straight half-way, and then bends suddenly down to form the margin of the large triangular pendant ear; this is slightly concave, pierced by close set puncta, and bordered all round by a raised margin, even at the head angles (fig 4, *a*), where the spines are attached. The fringe which encircles the front is strongly concave on its upper surface, with a thick flattened edge, and very convex below, except just at the margin, where it is plain (see fig. 3); it is closely beset by radiating rows of small holes, six or seven in a row. Of these rows on the upper surface the two outer pores are set close together just within the thickened edge, the next pore much more remote, and placed at rather a greater distance from them than from the three or four close set rows which range along the inner edge (see fig. 1*). The fringe is equal in width all along the front, the glabella not invading it, as it does in some other species. On the under side (fig. 3) the fringe shows a similar arrangement, the space between the second and third row being much more considerable than the others, and frequently rising into a ridge. The spines are not very strong; they project abruptly from the posterior angle, and are not thicker at their origin than elsewhere; their direction is a little inwards rather than directly backward. In some specimens they are as long as the glabella, in others longer than it.† The body, of six flat joints, is equal in length to the tail, and the axis alone

* Professor McCoy considers this an antennary pore, but this is very unlikely; it answers exactly to the place where, from M. de Barrande's discoveries, the ascending processes of the hypostome are attached.

† The facial suture cannot be traced in this species; in others, and especially in the section *Tretaspis*, it runs from the upper corners of the glabella to the eye, and thence to the posterior margin, just within the punctate border. I have formerly described it in this position, and cannot admit the opinion that it runs round the outer margin of the fringe. [See Barrande, Syst. Sil. 615, &c.]

shows any convexity; it is narrow, not occupying above one sixth the width of the thorax, and consequently is much narrower than the glabella; its rings show the usual division into two parts, an external arch and an articulating front portion. The pleuræ are truly flat, and only marked with a very faint diagonal furrow, but at their extreme end they are a little bent down and strongly indented (fig. 5). The fulcrum (fig. 5, *a*) occurs immediately before the tip. Tail rounded, truncate, less than a semicircle, concave, except the axis; the latter is moderately convex, narrow, and tapering to a point which reaches the margin; it is annulated by seven or eight faint rings, which are indented in the middle. The sides of the tail have seven or eight furrows, nearly reaching the margin; the upper one is straight or nearly so, the ends of the rest are strongly curved backwards. The very narrow margin of the tail is bent down vertically, so as to be invisible in a direct view; a small portion only of it is seen at *b* in fig. 1*, where the tip of the tail is decidedly recurved.

Variations—In many specimens the pendant ears are not so long as in our figured example, and consequently the posterior angles are more obtuse. This is particularly the case with those from the mining district of Shelve and Middleton, in Shropshire; these specimens have also smaller head spines, and the ears are much smaller, and are truncated so as hardly to reach back beyond the first or second thorax ring. This variation may be designated by the name *corndensis*, and if at all common (we have only seen it in specimens from one locality at present) may probably be characteristic of the female. We have figured a young specimen of it at fig. 2, and the head, magnified, fig. 6. The fringe in this specimen is scarcely concave, and the collocation of the pores into rows very indistinct toward the sides.

Affinities.—It is sufficiently distinct as not to be easily confounded with the common species, *T. concentricus*, Eaton, (known better in England as *T. Caractaci*, Murch.) The great size and pendant form of the large head-wings easily distinguish it from that species, and also from the *T. fimbriatus*, Murch. The concave character of the fringe distinguishes it from *T. radiatus*, Murch., which too has a square form of head, from the enlargement of the upper corners of the fringe, and divergent not parallel spines. Its nearest ally, to which, indeed, several authors have referred it, is *T. granulatus* of Wahlenberg and Dalman. Good means of comparison, however, are now given us by the accurate figures of Lovén, who of course has access to the very specimens described by the Swedish

authors, and from his figure and description, *T. granulatus* differs in the thicker crust, and in the size, different shape, and greater extension forwards of the glabella, which invades the area of the fringe in front, while in our species it scarcely ever reaches to it. The width of the axis, too, in the tail and thorax, is considerably greater, and the tail, though like in shape, is destitute of lateral furrows, and at its margin is steeply bent down ("præcipiti"). The punctuation of the head (if indeed Lovén's specimens were perfect in this part) shows but three or four rows at the most, and the outer row much enlarged (probably having two puncta in a common depression) while in ours they are numerous and of nearly equal size.

History.—First described by Sir Roderick Murchison from specimens gathered at Llangadock by the Rev. Henry Lloyd, after whom the species is named; this figure, however, though characteristic, was from a specimen with but five rings, evidently an accidental growth. The peculiarity, however, was noticed by Lovén,* who doubted its identity with his *T. granulatus* from this circumstance. Burmeister had previously, in 1843, united it with the Swedish species, and in accordance with his suggestion and from the great general similarity of the pendant ears and rounded tail, it was named *T. granulatus* by myself in the "Journal of the Geological Society," and in the lists drawn up by Professor Phillips and myself in the Survey Memoirs. I am glad now, from good specimens, and more close observation, to correct the error.

British Localities and Geological Position.—LLANDEILO FLAGS. In Carmarthenshire; Dynevor Park, and Mærdy bach, Llandeilo; Blaen-dyffryn-garn and Coed Sion quarries, Llangadock, abundant; in Shropshire, Middleton and the country about Chirbury and Shelve, also plentiful.

EXPLANATION OF PLATE VII.

- Fig. 1. Perfect specimen, from the Coed Sion quarries, Llangadock. Presented to the Museum of Practical Geology by the Rev. H. Lloyd.
- Fig. 1*. The same, magnified, showing the concave fringe perfect on the right hand of the specimen, and on the left, at *a*, the hollow impression left by its convex lower surface. The thorax and tail are represented as separate from the head; and at *b*, the abruptly vertical margin of the tail is just visible at the recurved tip.
- Fig. 2. A small specimen of the var. β , with the fringe flattened above (from pressure?); the ears in this variety are much smaller than in the ordinary form.

* Ofversigt Kōngl. Vetenskaps Akad. (1845), 109, pl. 2. f. 2.

- Fig. 3. Portion of the under surface of the fringe, magnified, showing the wide space between the second and third rows of pores, and at *a*, the thick flattened edge. The fringe is hollow, and its substance very thin.
- Fig. 4. The posterior angle, magnified; a raised edge, *a*, separates the fringe from the spine; the latter is often broken off at this point.
- Fig. 5. Extremities of two thorax rings, with strong indentations; *a*, fulcral point.
- Fig. 6. Head of fig. 2, magnified. At *a*, the indentations (for the attachment of the hypostome?) on each side is shown.
- Fig. 7. A section of the head and fringe, viewed rather from the upper side; *a*, the concavo-convex fringe; *b*, the narrow raised ridge between the fringe and the moderately convex glabella *c*; at *d* the cervical spine is shown.
- All the specimens in the Mus. Practical Geology.

The name of this genus can only be retained by general consent, for the typical species was formerly denominated *Cryptolithus*, and sufficiently described by Green; and had, indeed, received the name *Nuttainia* a few months earlier in the "Geological Text Book" of Eaton, the American geologist. But in this case strict priority may be allowed to yield to classical feeling,—the name *Trinucleus*, a strictly appropriate one, having been used in one of the earliest figures given of these or any trilobites, viz., in Dr. Llhwyd's paper in the Philosophical Transactions for August 1698. The '*Trinucleum fimbriatum*,' there figured, along with other trilobites, is the common Llandeilo species, now called *T. concentricus* or *T. Caractaci*.

In a short communication to the Geological Society, read March 1847, I endeavoured to explain the structure of the peculiar fringe of this genus, which had been beautifully figured just before by M. Rouault. However irregularly scattered the pores may seem in some of the species, they can generally be traced as arranged in radiate lines; in *T. radiatus* and *T. fimbriatus* very strikingly so indeed.

If these holes were elongated in the direction of the radii, so as to coalesce with each other, the intervening ridges would become hollow spines standing out from the head margin, and we should then at once recognize them as identical in structure with the marginal spines so characteristic of *Acidaspis*, and a few other genera. On the other hand, in the genus *Harpes*, not yet published in these Decades, the separation of the expanded fringe has not proceeded so far as in *Trinucleus*, the puncta in that genus not even piercing through the fringe, but only impressed upon it.

This genus, like so many others, is now ascertained to undergo metamorphosis, at least so far as increase in the number of thorax rings is concerned, M. Barrande having found the common species with from 0-6 body rings; and a specimen of it with four rings furnished M. Corda with materials for the foundation of his genus *Tetrapsellium*, a name which must of course be cancelled. The late division of the genus by Professor M'Coy into *Trinucleus* and *Tretaspis*, depends partly on this accidental circumstance; but the group *Tretaspis* will form a convenient sub-genus, distinguished by the other characters he has pointed out,—the glabella furrows, the more distinct ocular tubercle, and facial suture, &c.

Trinucleus frequently occurs in a rolled-up form, as figured by Beyrich and Rouault. The genus appears to us strictly Lower Silurian; the specimens said to have been obtained from Wenlock Shale are not yet well authenticated.

SECTION I. TRINUCLEUS proper.

1. *T. Lloydii*. Above described.
2. *T. concentricus*, Eaton. *Trinucleum fimbriatum vulgare*, Llhwyd (1698), Phil. Trans., v. xx. tab. add. f. 9. Ichnogr. Brit. (1690), tab. 23. at top. *Trilob.* Brongniart, Crust. Foss., t. 4. f. 6, 7. Bigsby, Ann. Lyc. Nat. Hist. New York, 1824, vol. i. pl. 15. f. 1. *Nuttainia concentrica*, Eaton, Geol. Text Book (1832), pl. 1. f. 2. Hall, Pal. New York (1847), pl. 65 and 67. *T. Caractaci*, Murch. Sil. Syst., pl. 23. f. 1. *Ampyz* (*Cryptol.*)

Caract., Emmr. (1839), Diss. 51, bona. *A. tessellatus*, ib. 50. *T. ornatus*, Salter, Quart. Geol. Journ. (1847), v. iii. 253. (including all synonyms); Mem. Geol. Surv., v. ii. pt. 1. pl. 9. f. 1, 2. *T. Caractaci* and *T. gibbifrons*, M'Coy, Pal. Foss. Woodw. Mus., pl. 1 E. f. 14. *T. Goldfussii*, Barr. (1853), Syst. Sil. de Böhème, pl. 30. f. 29–40. *T. ornatus*, ib. f. 41–60.

—*Junior* (four body rings). *Tetrapsellium pulchrum*. Corda, Prodr., f. 18. [mala].

T. ovatus latus, fere rotundus, fronte subangulato, glabellâ obovatâ genis paullo longiore, gibbâ, nec lobatâ, fimbria subtus angulatâ insuper planâ, interdum lentè concavâ, poris crebris quincuncialiter dispositis aut oblique radiatis, in ordines 4–5 concentricos (ad frontem sæpissime interruptos) collocatis; alis modicis, spinis longis divergentibus; cervice spinifero; caudâ thorace breviorè, axi convexo ad apicem lente decurvo, lateribus paullo concavis radiatim 5–6 sulcatis, margini abrupto declivi.

There are three if not four principal varieties of this variable species, the differences mainly consisting in more or fewer rows of pores being continued round the front, and the glabella being sometimes as broad as the cheeks and sometimes narrower. But the differences are by no means enough to separate them as species. Variety δ , indeed, differs so much that if it were not for intermediate specimens, it would be difficult to believe it the same. A trifling alteration is necessary in the arrangement of the varieties from that given in the Quart. Geol. Journ. vol. ii.

Var. β . *Caractaci*. Murch. l. c.

—*punctis crebris approximatis, ad frontem in ordines 4 continuos dispositis, glabellâ latâ.*

Localities.—Welshpool; Dinas Mowddwy and Bala, North Wales, in Bala Rocks.

Var. ϵ . *Portlockii*. Salter.—*T. Caractaci* and *T. latus*, Portlock, l. c. pl. 1 B.

—*fimbriâ angustiorè, punctis ad frontem subradiatis et in ordines 3 contractis; glabellâ subclavatâ genis paullo angustiorè, caudâ brevi.*

Localities.—Tyrone; Desertcreat; passing insensibly into the next variety.

Var. γ . *elongatus*. Portlock, l. c. f. 7.

—*fimbriâ angustâ, punctis ut in præcedenti; glabellâ angustâ clavata; caudâ longiorè, apice nec decurvo.*

The lateral ribs of the tail are very distinct in this variety, the elongation of which is not entirely due to pressure and cleavage; several specimens present the same characters; the whole axis is narrower, the tail longer, and with a raised margin; the lateral ribs, 6 or 7, very distinct; the apex not decurved, but rather elevated. We think it merely the male of it.

Locality.—With the last, Tyrone.

Most of the Bala, Llandeilo, and Pembrokeshire specimens have the fringe with only three puncta in front, and the glabella short, broad, and gibbous; they agree perfectly with *T. concentricus*, and help to establish the passage into the next variety.

Llandeilo and Pembrokeshire varieties, with narrow glabella, and the puncta in somewhat sunk short radii in front, but with the upper angles of the fringe not expanded, connect the above varieties with—

Var. δ . *favus*. Salter, Mem. Geol. Surv. l. c. pl. 9. f. 3.

—*capite transverso, rectangulari, fimbriâ angustâ antice punctis paucis radiantibus; angulis externis quadratis, poris magnis favosis; glabellâ elongatâ.*

Of this curious variety some have the angles more expanded than others. Where the enlargement of the pores takes place the fringe is also convex, and the appearance is just that of honeycomb.

Localities.—Narberth, &c. in Pembrokeshire; also Llandeilo; Middleton, near Chirbury, Shropshire.

Var. α . *Goldfussii*, Barr. (*Sternbergii*, Salter, Geol. Journ. l. c.) is the *Trimucleus* so frequent in the sandstones of Bohemia. It differs little from var. β , except in having closer pores. Specimens of equal size with ours would scarcely differ at all. *T. ornatus*, Sternb., has the pores more remote, and is much more like the common Bala forms

which are intermediate between var. β and ϵ . It has long and curved spines, a character which our British specimens are never perfect enough to show. Hall's *T. concentricus* shows similar variations in the fringe as ours do, but the tail in his figures is made too blunt. We have it from the Hudson River group, of the usual short subtriangular form.

There is no end to the variety of names under which this fossil has passed. It appears, from Hall's account in the "Palæontology, New York, 235, note," that *Nuttainia concentrica* is the oldest name, having been published in Eaton's Geological Text Book in 1832, and forming the type of his genus. Green's name, *Cryptolithus tessellatus*, though published the same year, was subsequent to it. Sternberg's name, *T. ornatus*, not being put forth till 1833, must give way, and if we have not yet got at the earliest name, we must be ready to change it again. However, as Hall was the companion of Eaton, and collected the very specimens described, his decision must be considered final; and the name *Trin. concentricus* must be applied for the future to this cosmopolite fossil. If we were to go back to Llhwyd's name, certainly the earliest of all, it should be *T. fimbriatus*; but that would be contrary to rule, and only create confusion.

In the Quarterly Geol. Journal, vol. iii., p. 253, I have endeavoured to combine the synonyms of the species; and I see no reason to alter the nomenclature there proposed. I had not then observed that Beyrich had, a year before, suggested the union of *T. ornatus* from Bohemia with the British fossil; but this was from figures only.

Localities.—North and South Wales; everywhere in Llandeilo and Bala Rocks; Horderly and Cheney Longville in Caradoc sandstone; Caradoc shale, banks of the Onny, near Cheney Longville (Sedgwick). Lower Silurian Rocks of Tyrone, Wexford, and Kildare, Ireland; not yet in Scotland.

Foreign Distribution.—North America and Canada. Bohemia. Not yet found in France or Spain, where its place seems to be taken by *T. Pongerardi*, Rouault. Nor is it found in Sweden, where *T. seticornis* is plentiful.

3. *T. Thersites.*—sp. nov.

T. capite lineas 4 lato, semicirculari, fronte paulum angulato, glabellâ genis depressis longiore angustissimâ valde elevatâ et acuticarinatâ; fimbriâ angustâ, planâ nisi lineâ medianâ paulo incrassatâ, punctis satis crebris nec radiatis in ordines tres concentricos collocatis; cervice brevispinoso; sulco verticali distincto, sub genis latiori; angulis posticis haud expansis, spinis—?

The second or middle row of pores on the fringe is more distinct than the others, on account of the slight swelling of the fringe along that line; and at the angles a few pores are interspersed between this row and the cheeks. The remarkably elevated and carinated glabella easily distinguishes this species, which has remained long in our collection, indicated as an undescribed *Trinucleus* in Professor M'Coy's Mss.

Locality.—Tramore, Waterford; in Lower Silurian slates.

Section II. TRETASPIS, M'Coy.

Ocular tubercle distinct; eye-line cutting the posterior margin, but the head not separable at the sutures; glabella lobed.

4. *T. seticornis*, Hisinger (*Asaphus*), Leth. Suec., t. 37. fig. 2. *A. cyllarus*, ib., fig. 3. *T. seticornis*, Lovén, Ofvers. Kongl. Vet. Akad. (1845), t. 2. fig. 1. Portl. Geol. Rep., pl. 1 B. fig. 8. *T. radiatus*, ib., fig. 9. *T. Bucklandi*, Barr. (1846), Not. Prelim. 31. id. Syst. Sil. de Böhème (1853), pl. 30. f. 14–16. *Tretaspis setic.*, M'Coy (1851), Pal. Foss. Woodw. Mus. 147.

T. ellipticus, corpore plano, capite convexo reticulato; glabellâ genis longiore clavatâ antice inflatâ utrinque 2–3-sulcosâ; fimbriâ undique deflexâ, insuper convexâ, margine recurvo incrassato, subtus planiore; poris in ordines 5, 6 collocatis, radiantibus; angulis posticis longispinosis, spinis rectis parallelis; caudâ brevissimâ rotundatâ, lateribus lævigatis, margini lato declivi.

The fringe is always steeply bent down, and follows the declivity of the cheek without any change of direction, except in some specimens a gentle convexity. The pores

are in 6 rows (5 in younger specimens), of which the outer two are placed close together in the deep furrow immediately before the thickened striate margin. The concentric rows are more distinct than the radiating ones in Bala specimens,—in those from Haverfordwest and Ireland the radiation is more manifest. The specimens from the latter locality show the same reticulate character of surface of the head which is seen in our next species. This structure is but rarely to be seen in our other specimens,—nor can we find it at all in two from Sweden in the collection of the Geological Society. Perhaps it is easily abraded; the specimens agree in all other respects.

Localities.—LOWER SILURIAN. In Ireland; Desertcreat, Tyrone; Chair of Kildare; Newtown, Wexford. In Wales; Bala; Llanfyllin; Haverfordwest, &c.; chiefly in limestone strata.

Foreign Localities.—Lower Silurian. Dalecarlia. Kœnigshof, Bohemia (Barrande.)

5. *T. fimbriatus*, Murchison, Sil. Syst., t. 23, fig. 2 (head only.) *Ampyx* (*Cryptolithus*) *fimbriat.*, EMMR. (1839), 52. (not of Portl.) *Tretaspis*, M'Coy, Pal. Foss. 146. pl. 1 E. f. 16.

T. latè ovatus depressus, capite truncato, undique reticulato-punctato; glabellâ convexiusculâ, genas longitudine æquante sed angustiore, utrinque sulcis tribus brevibus; fimbriâ subtus concavâ; insuper primum planâ radiatim sulcatâ, deinde angulatim deflexâ; parte planâ radiatim sulcatâ, poris in utroque sulco 4; parte externâ ad marginem singulo pororum serie ornatâ; angulis capitibus haud expansis, spinis brevibus tetragonis divergentibus; thorace abbreviato; caudâ thorace brevior, subtriangulatâ, lateribus læviter 5-costatis, margini declivi.

A specimen of this species in the young state, 2 lines long, has been found with only 5 thoracic segments; it however soon attains the full number. The head is very wide: the fringe is very regular in width round the head, and not invaded at all in front by the glabella as in the last species. It is flat and deeply marked for the first half with sunk radii, full of close-set pores, then rather abruptly deflected and furnished with but a single row on the outer portion.

The tail figured on the same slab with the head of this species in the Sil. Syst. belongs to *Ampyx nudus*; and Burmeister has described it as belonging to the present species; the true tail is short and few-ribbed, as in all the other *Trinuclei*.

Localities.—Only yet found at Bault in Radnorshire; it is exceedingly abundant in the lane leading to the farmhouse called Pen-Cerrig, on the west side of the hill, where it occurs with *Ampyx nudus* and *Agnostus M'Coyii*, (*A. pisiformis*, Murch.)

6. *T. radiatus*, Murchison, Sil. Syst., t. 24, fig. 3. *Ampyx*, EMMR. l. c. 52. (not of Portlock, Geol. Rep., nor of M'Coy, Pal. Foss. 146).

T. paullo adhuc cognotus; præcedenti simillimus, nisi angulis superioribus capitibus expansis multipunctatis, glabellâ longiori.

Except in the expanded upper angles of the fringe, which consequently contain at this part many more pores in a row, this does not appear to differ from the last species. The style of the fringe is exactly similar, and the pores placed in furrows in the same way.

The enlarged angles are the chief character, but in some specimens of *T. fimbriatus* there are slight indications of this. As *T. concentricus* varies in this respect it is not too much to suppose *T. radiatus* to be a variety in the same way. The spines, however, are less divergent, and the fringe is invaded in front by the glabella, which too is longer in proportion. In this species not all the pores appear to penetrate the fringe; the outermost and innermost certainly do; the intermediate ones, if they do pierce through, are smaller.

Locality.—Trilobite Dingle, Welshpool [Sir R. I. Murchison.] Coll. Geol. Society.

J. W. SALTER.

August, 1853.

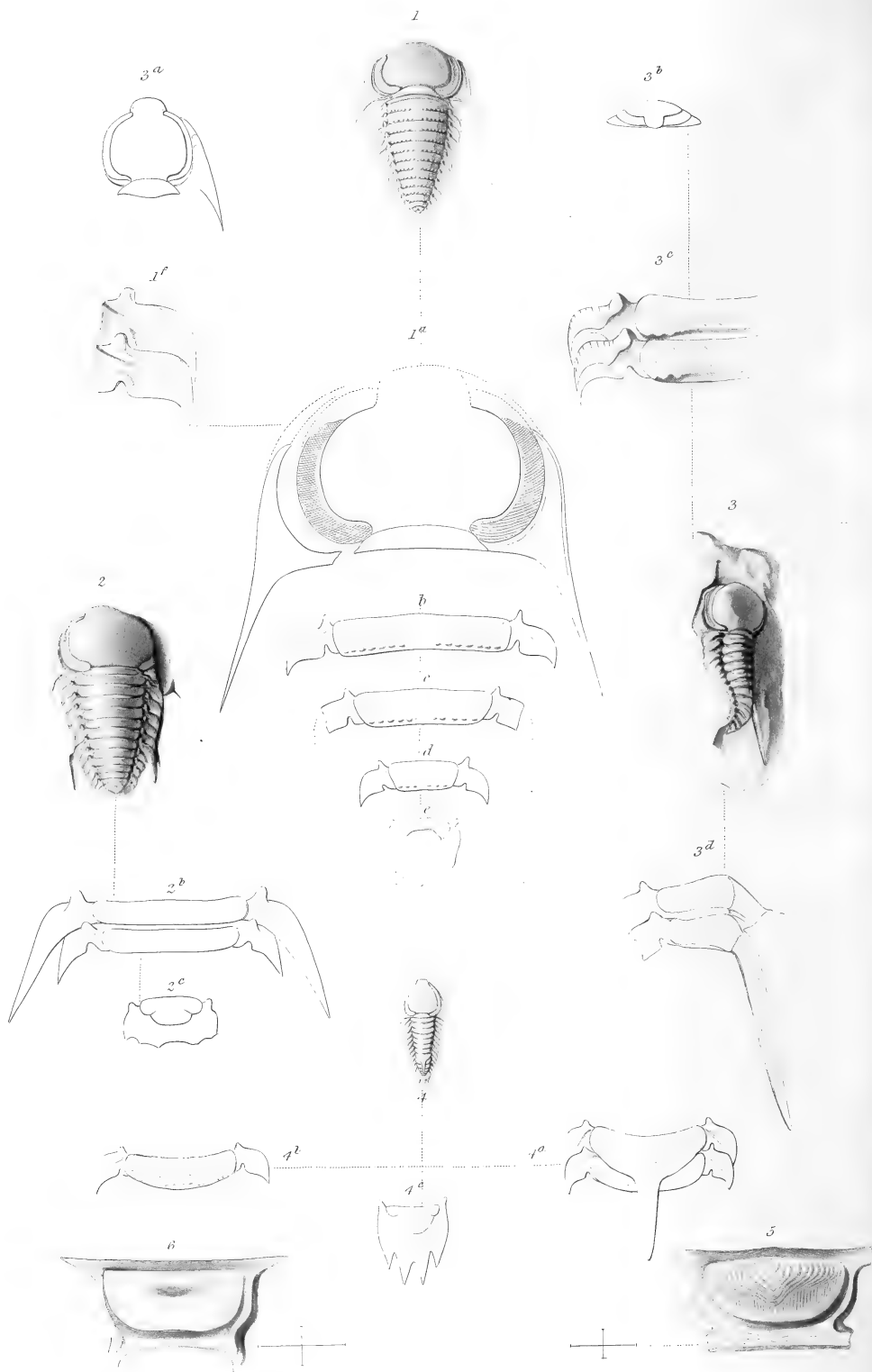


Fig. 1. REMOPLEURIDES COLBII Portlock | Figs. 3, 4. R — DORSOSPINIFER — Portlock
 2. R — LATERISPINIFER D? | 5, 6. — Hypostome of Remopleurides

BRITISH FOSSILS.

DECADE VII. PLATE VIII. Fig. 1.

REMOPLEURIDES COLBII.

[Genus REMOPLEURIDES. PORTLOCK. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadæ.) Body attenuated behind; glabella circular, occupying the greater part of the head, with an abruptly produced front; its sides closely encircled by the very long smooth eyes; eye line ending posteriorly close to the axis; cheeks small, produced into spinæ; hypostome truncate in front; body segments 11, the 7th or 8th with appendages, the axis broad, the pleuræ falcate; tail minute, the axis very short, of 2 or 3 segments, the border spinose [4 spined.] *Caphyra*, BARR: *Amphitryon*, CORDA.]

[Sub-genus *Remopleurides*. Glabella furrows quite obsolete.]

DIAGNOSIS. *R. longi-ovatus*; glabellâ maximâ, quam longâ latiori, ad frontem inter oculos angustâ; genis parvis, in spinas breves divergentes extensis; thoracis axi latissimo, antè fere pleuram ter superante; pleuris brevibus (septimo haud producto?) fulcro ad axin appresso, in tuberculum longum valde protenso; caudâ subquadrata, axi abbreviato biannulato, [marginè quadrispinoso, spinis externis brevioribus.]

SYNONYMS. *Remopleurides Colbii*, PORTLOCK (1843), Geol. Rept., Tyrone, 256, pl. 1. fig. 1. *R. Kolbii*, EMMRICH (1845), Neues Jahrb. 45. M'COY (1846), Syn. Carb. Foss. Irel. 43.

The fortunate discovery by Lieutenant-Colonel Portlock of three or four species of this most remarkable group, enabled its discoverer at once to establish it as a new genus, allied to *Olenus* and *Paradoxides*, a relation borne out by many points of its structure. A more perfect specimen, since found in Ireland by the Geological Survey, enables us to supply some points left doubtful in his descriptions, and we have figured afresh three of his original specimens to illustrate a suggestion thrown out by him, that the variations in proportion observable in these closely allied species may be sexual rather than specific characters. New species have been discovered both in Britain, Sweden, and Bohemia, but except in these countries the genus is not yet known.

Description.—An inch long, and five and a half lines wide, generally convex, of a long ovate form, blunt and rounded in front, narrow and pointed behind. The head occupies not quite one third of the length, and is considerably wider than the body; it is chiefly composed of the large, smooth and convex glabella, which is widely urceolate, the sides strongly arched outwards, so as to form a transverse broad oval, exclusive of the produced and narrow tongue-like front. The produced front is broken off in this specimen, but doubtless existed, as in the other closely allied species; we have indicated its shape by dots. This contraction of the glabella in front, so characteristic of the genus, is due to the excessive prolongation of the eyes, which would meet in front, but for this narrow projection. They completely encircle the sides of the glabella, separated from it only by a narrow rim or eye lobe, and extend their course backwards into the neck furrow, approximating below as they do in front, and indenting a little the base of the glabella. The eyes are of equal width throughout, and are smooth externally, but when decorticated show a closely faceted surface. They are subtended by a raised border along their lower edge.

The wings or free cheeks are small and subtriangular, extending at least as far as the eyes do in front (see fig. 1, *a*); they are striated, have no distinct border, and are prolonged behind into a short and slender spine, which is directed a little outwards, and reaches as far as the third body segment. The eye line is not traceable in front, behind it runs, as in all the genus, vertically beneath the eye, and consequently ends close to the axial furrow. The neck segment is not quite so broad as those of the body, and is separated from the glabella by a sharp furrow.

[At fig. 5, we have represented the hypostome either of this or of one of the two following species. Colonel Portlock has figured this specimen in a reversed position,* as possibly the internal cast of the head; but it is clearly an hypostome, and a comparison of its characters with those of another species of Remopleurides, figured by M. Corda in his work on Trilobites, pl. 6. fig. 58, enables us without doubt to refer it to this genus. From its size it is probably that of one of the three species represented on our plate; and it was found at the same locality with them in Tyrone.

It is four lines broad, and two lines high, nearly rectangular, with the base very broad and quite straight, and its outer angles elongated; it then contracts a little in width, and is strongly notched on the side

* Report, Tyrone and Londond., pl. 24. fig. 10. p. 470.

just before it again suddenly expands to form the broad truncate tip; the front edge is very slightly sinuous. The points of the front angles are broken off, but they appear to have been produced laterally rather than decurved, in which they differ from those of fig. 6. A narrow, but distinct sulcus all round distinguishes the central more convex portion, which is straight at the upper or basal margin, but semi-circular in front. A slight prominence rises on the middle of the upper margin, on each side of which strong imbricating striæ descend and meet V fashion along the median line. They extend only along the upper edge, and beneath them fine vertical striæ arise, and cover nearly all the rest of the central space. Concentric striæ run round all the margin, both on the front and sides, and the latter are also marked by a flexuous keel which follows the curve of the lateral notch.

Fig. 6, a specimen from Waterford, where the *R. dorsospinifer* occurs with it, differs very little in size or outline; it has the flexuous keel and notch on the sides, and the expanded angles of the base and apex. But the latter, instead of being extended outwards (as they appear to do in fig. 5), curve down and forwards, forming short falcate lobes *b, b*,—the front margin is a little more sinuous. The specimen is more compressed, and the central portion therefore less convex, though of the same shape. The large imbricating striæ too are not preserved. The differences above pointed out are, however, very trifling; and we believe both are of the same species, fig. 5 having the falcate lobes broken off.]

Body segments 11; the axis is convex, and very broad, and in front nearly three times the width of the diminutive pleuræ; posteriorly it is narrowed to one third of its width in front, and in the last segment is not quite twice as broad as the pleuræ, which diminish but little as they recede from the head. The seventh pleura on each side is broken; but enough remains to show that it was not in this specimen materially larger than the rest. All are short, falcate, directed backwards and downwards, with a very short oblique furrow, and furnished on the forward edge close to the axis, with a strong projecting fulcral tubercle; the hinder edge with a corresponding deep notch, the margin of which is raised all round. The pleuræ are striated obliquely. The segments of the axis are crossed by tranverse lines, and covered with faint tubercles; a row of strong tubercles along their hinder edge gives a serrate margin to each segment. There is no appearance of any enlargement of the eighth segment of the axis. Tail squarish, wider in front than

behind; the axis short, its length less than half that of the tail, composed of two joints, an upper ring, which is very narrow in the middle and is produced downwards at the side, and a rounded terminal joint. On the forward edge, and close to the axis on each side, is a strong and prominent fulcral tubercle like those of the pleuræ. The flat limb terminates in four rather short teeth all directed backward, the two lateral ones, though nearly equal in size with the others, not being produced so far back. These teeth are broken off in the specimen figured, but the description is taken from well preserved specimens found in North Wales, and apparently of the same species; the surface of the limb and of its teeth is finely striated across with close waved lines.

British Localities and Geological Position.—LOWER SILURIAN; Desertcreat parish, Tyrone, in argillaceous schist, fig. 1. Bala limestone, North Wales.

REMOPLEURIDES LATERISPINIFER.

Fig. 2.

DIAGNOSIS. *R. longiovatus*, glabellâ maximâ quam longâ latiori, ad frontem inter oculos angustâ; genis parvis, in spinas breves extensis; thoracis axi latissimo, anticè pleuram ter et plus superante, pleuris brevibus, septimo utrinque longè producto, fulcro appresso elevato; caudæ axi abbreviato biannulato; (margo omnino caret, ut in precedenti habendus.)

SYNONYMS. *R. laterispinifer*, PORTLOCK (1843), l. c., pl. 1. fig. 2. M'Cox (1846), Syn. Carb. Foss. Irel. 43. CORDA (1847), Prodr. Böhm. Tril., 113. t. 6. fig. 59 [mala].

Description.—Length fourteen lines, width eight lines. The general shape and convexity, the size and form of the glabella, cheeks and eyes, are the same as in the preceding description. But the head is rather more than one third the whole length of the body, and the width of the tongue-like front of the glabella (which could not be accurately determined in the foregoing species), is somewhat less than half that of the entire glabella.

The axis of the body is in front nearly four times as wide as the short pleuræ, in the last ring it is only one third of this width, and about twice the width of its pleura; its segments are each tuberculate along their hinder edge, as in the last species, and show some faint traces of granulation over the surface; the seventh pleura on each side is abruptly lengthened and produced backwards (not

so much outwards as in our figure) as far as the origin of the tail. In all other respects the body rings agree with those of the *R. Colbii*.

The tail is broken, and has lost all but the anterior margin and the axis; the latter is of two rings, and their shape is as in the last species. Immediately beneath the axis there is an emargination like that represented in Portlock's figure; but it is, I believe, a fold of the incurved under portion, and is certainly not a part of the margin of the tail, which indeed, from the proportions of the fragment left, would have been of just the shape of that of *R. Colbii*.

British Locality and Geological Position.—LOWER SILURIAN. Townland of Bardahessiagh, Tyrone, in micaceous sandy schist.

REMOPLEURIDES DORSOPINIFER.

Figs. 3, 4.

DIAGNOSIS. *R. elongatus longiovatus, glabellâ maximâ quam latâ longiori, ad frontem inter oculos angustâ; genis parvis, in spinas breves extensis; thoracis axi latissimo, anticè pleuram ter superante, segmento octavo incrassato, in spinam fortem extenso; pleuris brevibus, fulcro ut in præcedenti; caudæ margini quadrispinoso, spinis externis brevioribus.*

SYNONYMS. *R. dorsopinifer*, PORTLOCK (1843), l. c., pl. 1. fig. 3. also fig. 4. M'COY (1846), Syn. Carb. Foss. Irel. 43.

Description.—Length one inch. The general shape is more elongated than in the two foregoing species; and the anterior produced portion of the glabella is scarcely more than one third its entire width; otherwise the proportions of the head and its parts are very similar. The body rings, except in the narrower axis, agree in structure with those of *R. Colbii*, and *R. laterispinifer*; the rings of the axis have their posterior edge serrated, and their surface granulose; and the pleuræ are similar in shape, and in the position of the fulcrum. The chief difference is in the comparative width of the axis, which is not three times the width of the pleuræ in front, and posteriorly is not so much narrowed, being little less than half the width it has in the anterior part. The seventh pair of pleuræ, too, are not at all elongated, at least not in the young and perfect specimen, fig. 4 (in fig. 3, Portlock's original specimen, this portion is broken off). The eighth segment of the axis is incrassated, and gives birth to a short spine which extends backward, lying closely on the segments, nearly to the end of the tail; the tip of the spine is a little recurved, and its surface striated. The incrassation of the

eighth segment is only seen in the exterior crust (fig. 4, *a*); the interior cast of the same segment (see figs. 3 and 4) shows nothing of it. The tail is oblong, the posterior edge cut into four strong teeth, the two outermost shorter than the others. The axis two-ringed, as in the other species.

British Locality and Geological Position.—LOWER SILURIAN; Desertcreat parish, Tyrone (fig. 3.), in fine micaceous sandy schists; Tramore, Waterford (fig. 4), in arenaceous slate.

Variations.—These three supposed species have purposely been described and figured together, in order to show how very trivial the variations are between them, except, of course, in the remarkable appendages to which the specific names refer. *R. laterispinifer* has the general axis somewhat broader than *R. Colbii*; and this again than *R. dorsospinifer*. The two first-named species, indeed, agree very nearly in its proportions, as it tapers in the body segments rapidly from front to back. In the last form, which is more elongate and narrow than either, this tapering is not nearly so rapid. But the general shape, configuration of the glabella and cheeks, the extent, size, and position of the eyes, the broad axis of the body rings, and the short hatchet-shaped pleuræ, are the same in all; each has the remarkable produced fulcral point, placed close to the axis—and the tail, as far as it is preserved in each species, shows no difference in character. The surface, too, appears granulose in all, and the posterior edge of the body segments is serrated by a projecting row of tubercles.

The only striking peculiarities reside in the appendages, the first having neither lateral or dorsal spines; the second having the seventh pair of pleuræ produced into spinous points; and the last, together with a more elongate general form, is furnished on the eighth segment of the axis with a strong dorsal spine.

Sex.—How far these variations may be regarded as differences of sex, is a point worthy of consideration. It is well known that a narrower form, and additional ornament frequently characterizes the male of other Crustacea. In the former Decade we have endeavoured to apply this to the observed differences between certain species of *Phacops*,—and in the present one to *Cyphaspis*.

M. de Barrande has, indeed, shown that there generally exists among the Bohemian Trilobites a broad and narrow form of each species; and he has particularly noticed this in the case of *Acidaspis* (*Odortopleura*), and considered the narrower form that of the male.

He also mentions a variation in the number of spines, but this does not appear to be connected with the variation in form. We are not, therefore, yet warranted in supposing that very considerable difference in the appendages may be referred to sex. It is, however, we think, allowable to look for independent characters in a group that has no exact living representatives. Burmeister has shown us that we cannot tell at what segment of a trilobite's body the thorax really terminates, as that is determined by the position of the generative pores. But, as it is extremely likely this should have some external mark, we venture to suggest that the seventh or eighth segment in this genus is the point where the thorax terminates and the true abdomen begins.

Unfortunately, among those Entomostraca most nearly allied to Trilobites, we have not instances of such variation. The sexes of *Apus* do not appear to differ much externally, and in *Limulus* a notch in the front part of the shield of the head, and some trifling differences in the feet, are all that mark the male.

But if we turn to the *Isopoda* we have a direct analogy, at least in one group. In *Serolis*, it is true, there are but slight differences in the feet, the external form remaining the same. But in several species of *Sphæroma*, *S. armata*, &c., the last or last but one ring of the thorax is prolonged into a spine, very like that on the fossils; and in one species, *S. diadema*, if not in others, it is the characteristic mark of the male; in the female it is absent, or reduced to a mere tubercle.

Without, therefore, prematurely attempting to alter the nomenclature applied by their discoverer, I may state it as my belief, that in the *Remopleurides dorsospinifer* may be recognized the narrow form and dorsal spine of the male; in *R. laterispinifer*, a mature broad female form, with the eighth pair of pleuræ dilated as ovigerous supports; *R. Colbii*, which is intermediate in form, and destitute of these appendages, I would suggest to be the immature female; and should further observation confirm this view, the species should be re-united under the name of *R. Colbii*.

Affinities.—*R. longicostatus*, Portlock, of which we have given the characters further on, differs at a glance from each of the foregoing species, not only by the great width between the eyes in front, but by the narrow body axis, which is scarcely wider than the large falcate pleuræ. This is the only species with which they can be compared; for the *R. (Caphyra) radians* has the glabella strongly marked by three segmental furrows on each side, and belongs to a different section of the genus. *R. platyceps*, M'Coy, besides having

a glabella (the only part known) considerably wider, which might be due to pressure, has this portion tuberculate, as I found by examination of the original specimen, in 1845.

History.—Very little has been contributed to the history of these species since Col. Portlock's account, for the simple reason that the species are very rare in Britain, and have not yet occurred in other countries; and the author himself did not clearly make out either the number of body rings or the structure of the tail, and he overlooked the eyes. The genus was at once admitted in the classification proposed by Dr. Emmrich in 1845, and placed at the end of the Olenoid group; but the number (12) of body rings proposed there, although an improvement upon Col. Portlock's enumeration (who included the neck segment and the first of the tail) was erroneous, and the distinction between it and *Olenus* very obscurely defined, owing chiefly to the original mistake about the eyes. M. Corda, too, in his general descriptions and figures of the Trilobite genera, corrected the description of the eyes in *Remopleurides laterispinifer*, which he, however, represented with thirteen body rings and a bifurcate tail. A closely allied species from Bohemia is there more correctly figured and described. The genus appears to be entirely Lower Silurian.

EXPLANATION OF PLATE VIII.

- Fig. 1. *Remopleurides Colbii*. Col. Portlock's original specimen, Tyrone; and the same magnified, and dissected; in fig. *a*, the left free cheek or wing is represented as separate, but it is not known whether the wings were connected in front—the front portion of the head is restored in dotted lines; at *b*, the 3d or 4th thorax segment showing the prominent fulcræ * * *; at *c*, the 7th segment, the broken pleuræ appearing not to have been produced into spines; at *d*, the last segment; *e*, the tail, its serrate edge restored from better specimens; *f* shows the striated external surface, and the groove and fulcrum of two of the pleuræ. Several portions of the crust are preserved in this specimen.
- Fig. 2. *Remopleurides laterispinifer*. The original specimen; an internal cast only; at 2 *b*, the 7th and 8th thorax segment magnified; at 2 *c*, the broken tail; the outline restored in dots.
- Fig. 3. *Remopleurides dorsospinifer*. Original specimen; at 3 *c*, two of the thorax segments in the front pleuræ, internal cast, showing the grooves deeper than in fig. 1 *f*; 3 *d*, the 7th and 8th segment of the axis, the latter with the long dorsal spine.
- Fig. 3 *a*, 3 *b*. Two views of the head of another specimen, same locality; also figured by Portlock.
- Fig. 4. A young perfect specimen, Tramore, Waterford; somewhat elongated by cleavage; 4 *a*, 8th and 9th thorax segments, external surface; 4 *b*, internal cast of the 8th, showing no enlargement; 4 *c*, the perfect tail, magnified.

Fig. 5. Hypostome of a species of *Remopleurides*; in all probability of one of the above species, with which it is associated in the rock; it shows the lateral indentations, but not the projecting outer angles; they appear to be broken off. Desertcreat, Tyrone.

Fig. 6. Probably the same species, from Tramore, Waterford; the lateral notches and projecting outer angles are very perfect.

Other British species of the Genus.

SECTION REMOPLEURIDES. Glabella furrows quite obsolete.

Sp. 4. *R. platyceps*, M'Coy, Synopsis Sil. Foss. Ireland, p. 44.

R. glabellâ (*adhuc solum cognotâ*) *ut in præcedentibus, sed bis quam longâ latiori, tuberculatâ.*

Locality.—Carrickadaggan and Greenville, Enniscorthy, county Wexford (M'Coy), in Lower Silurian rocks.

5. *R. longicostatus*, Portlock (1843), Geol. Rep. Tyrone, pl. 1. fig. 6. *R. longicapitatus*, *ib.* fig. 5.

DIAGNOSIS. *R. ovatus, glabellâ undique lineatâ magnâ rotundatâ, nec totum capitis latâ, quam longâ latiori, ad frontem inter oculos latâ; genis modicis triangulatis, in spinas longissimas paullo incurvatas extensis; thoracis axi postice attenuato, anticè nec pleuram bis excedenti, segmentis octo primis inermibus (reliqua absunt); pleuris satis longis falcatis, nunquam productis, fulcro proximo elevato.*

This fine species, with a rounded form of glabella, somewhat like the foregoing species, has the eyes much less extended forwards, the portion between being very large and broad. The pleuræ too are as wide as the axis, or nearly so, and the long head spines are produced backwards at least as far as the 8th body segment; beyond this, the specimen is imperfect. Fine wavy lines cross the glabella, and by these even portions of the head may be distinguished from the *R. Colbii* and its allies, which all appear to have this part smooth. *R. longicapitatus*, from the same locality, is a glabella only, somewhat elongated by lateral pressure; it agrees in all the other characters with the present species.

Localities.—Tirnaska, Tyrone, in sandy schist; Tramore, Waterford, in dark slate; Chair of Kildare, county of Kildare, in limestone. LLANDEILO OF BALA BEDS.

Sp. 6. *R. obtusus*, sp. nov.

R. parvulus, glabellâ lyratâ subconvexâ elongatâ, anticè latissimâ, oculis abbreviatis vir curvatis; thorace (segmentis primis) pleuris leviter sulcatis axi paullo angustioribus, fulcro haud eminente nec ad axin appresso.

Although imperfect, this is evidently quite distinct from any of the rest; the obtuse and wide front of the glabella and the consequently reduced size of the eyes readily distinguish it. The glabellar furrows are only just indicated, if at all existing. The fulcral segments are remarkable, for the fulcrum, instead of being strong and projecting, and placed close to the axis, is at some little distance from it, and does not project more than in ordinary trilobites.

Localities.—Desertcreat, Tyrone. [Survey Coll.]

SECTION II. CAPHYRA.

Glabella moderate, not inflated, with three pairs of furrows.

Sp. 7. *R. (Caphyra) radians. Caphyra radians* (glabella solum). Barrande, Notice Prelim. Syst. Sil. Bohême, p. 32. (1846). Sil. Syst. Bohême, 1853, pl. 43. fig. 33-39. *Amphitryon Murchisonii*, Corda (1847), Prodr. Böhm. Tril., t. vi. f. 58.

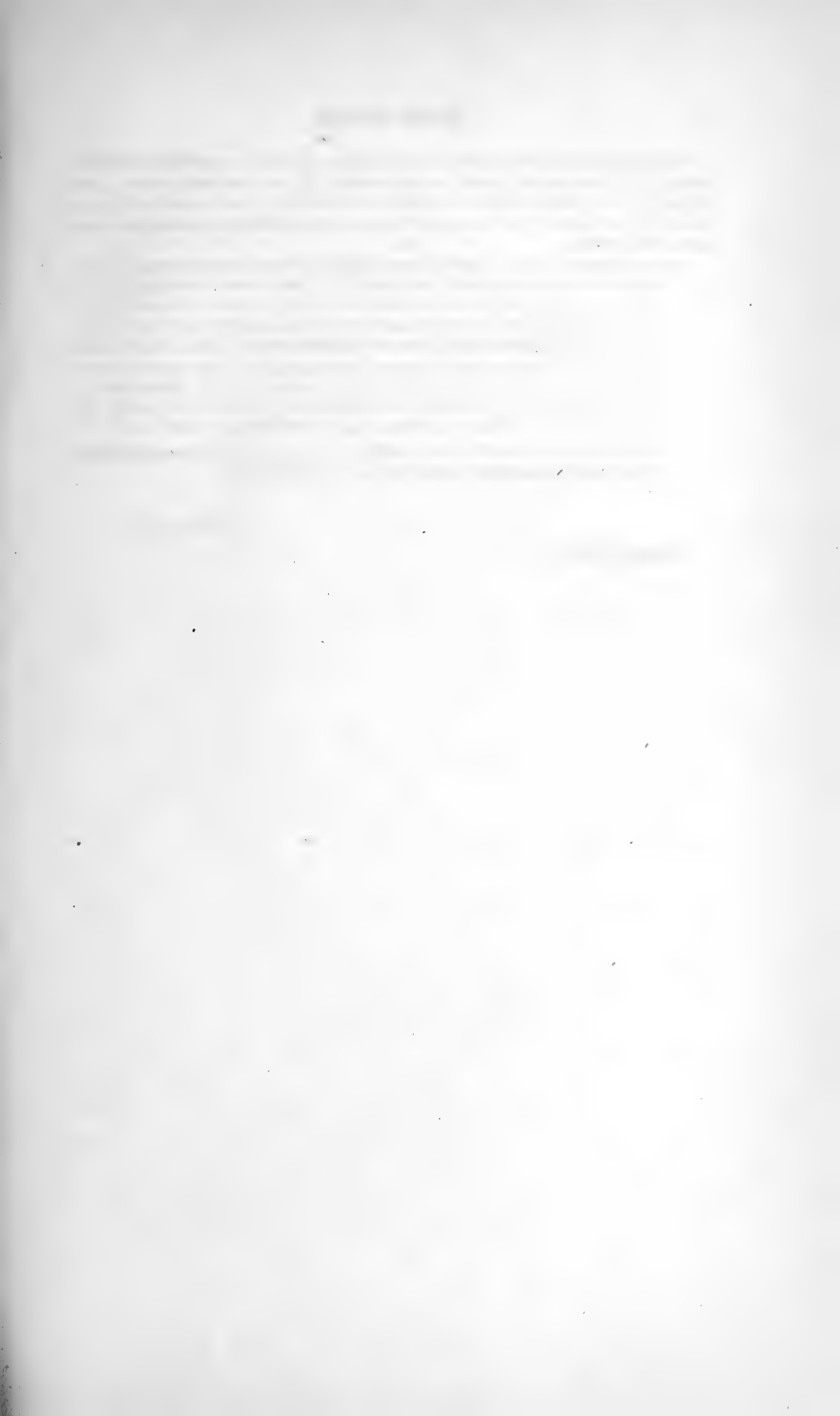
R. sesquincialis (in exempl. Brit.) *depressus, ovatus, glabellâ late urceolatâ, quam longâ latiori, antice angustissimâ; sulcis sursum curvatis, nec marginem attingentibus; oculis longissimis; genis dilatatis, angulis in spinas latas extensis; thorace segmentis 10, pleuris fulcatis, fere axin conveziorem æquantibus, fulcro proximo; caudâ longâ, quadrispinosâ, spinis externis longioribus.*

M. de Barrande, when in England, agreed with us in identifying this species; and we adopt the above specific name, believing it to be but common courtesy, when correcting the mistake of a careful and judicious author, to retain the name he imposed. M. de Barrande, it is true, described as a tail the reversed glabella of this species, but he carefully distinguished it from all other Bohemian trilobites; and M. Corda has conferred no advantage on science in changing both the genus and species, although he had fortunately obtained a perfect specimen. He has figured the eyes much too short; they curve round the glabella, and nearly meet in front, as may now be well seen in the lately published figure of M. Barrande, quoted above.

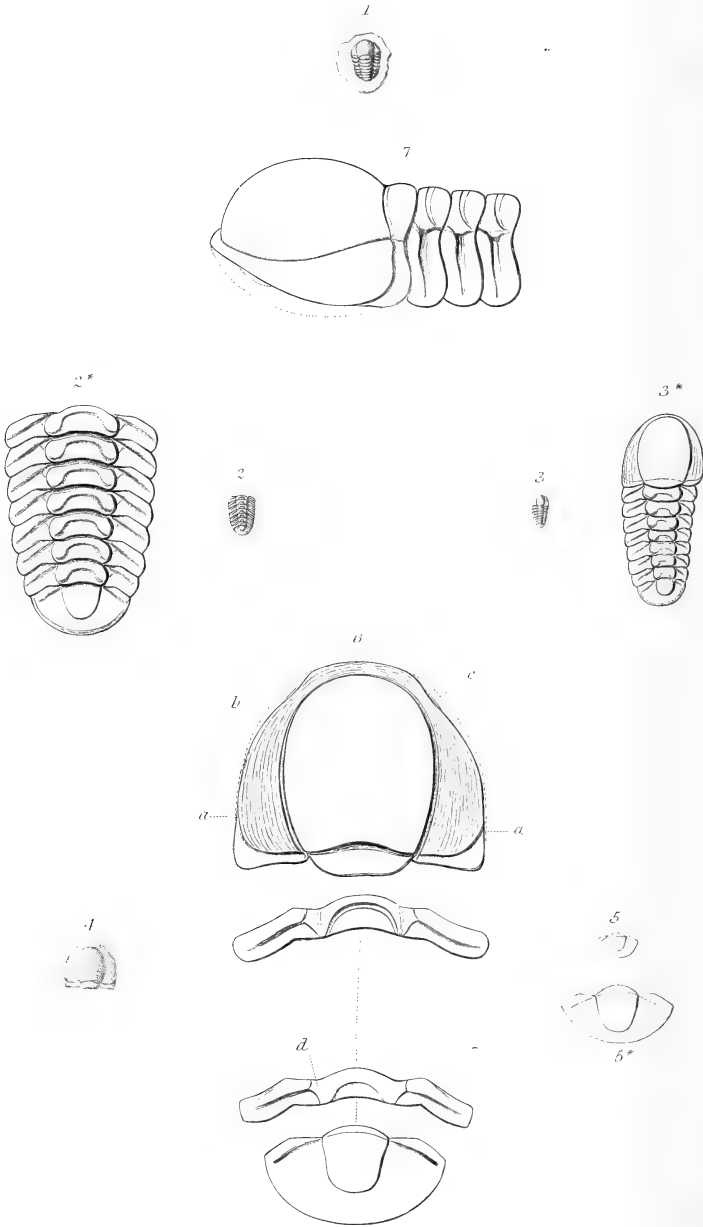
Localities.—Rhiwlas, near Bala, not unfrequent. We have specimens from Koenigshof, Bohemia, in the uppermost part of the Etage D. of Barrande.

J. W. SALTER.

August, 1853.







CYPHONISCUS SOCIALIS *Salter*

BRITISH FOSSILS.

DECADE VII. PLATE IX.

CYPHONISCUS * SOCIALIS.

[Genus CYPHONISCUS. SALTER. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadæ.) Body oval, convex; head large; glabella oval, gibbous, without lobes; facial sutures marginal in front, then in an oblique and nearly straight line to the *outer* margin; free cheeks very narrow. [Eyes very forward, minute, linear.] Thorax with seven convex segments, the pleuræ with fulcrum and groove, their ends truncate, not produced; tail small, of few (1?) segments, its axis entire.]

DIAGNOSIS. *C. minutus, glabellâ lævi, genis undique lineatis multo majore; sulco verticali profundo, per genas tracto, et ad angulum posticum obtusum sursum curvato; thoracis axi pleuras æquante; fulcro paullo intra dimidium posito; caudæ axi integro.*

SYNONYMS. *Cyphoniscus socialis*, SALTER (1852), Report Brit. Assoc., p. 57.

This minute crustacean literally swarms in certain reddish patches of the limestone at the Chair of Kildare, but has not yet been observed in other localities. It is evidently a member of the Olenoid group, to one genus of which, *Triarthrus*, it bears a strong resemblance in certain particulars. But it differs from it and all its congeners in the inflated form of the glabella, which is also destitute of lobes, in the small obscure eyes, and the fewness of the segments of the body. The eye has not been yet discovered, and there is so little indication of its place, that the animal might be supposed to be a blind trilobite, but that there is no instance known of a species with separable facial sutures being destitute of these organs. In the very few trilobites now admitted to be without eyes, *Agnostus*, *Ampyx*, some *Trinuclei*, &c., the facial suture is soldered. The converse however does not hold good, several genera with soldered sutures having large and well-developed eyes.

Description.—Length about one fourth of an inch. The general form is long oval or long ovate; the head, which is the broadest

* Name from κύφος, a convexity, and ὀπίσκος, asellus. Linnæus has used 'Oniscus' for small Crustacea of somewhat similar form.

part, occupies two fifths of the entire length; it is regularly and highly convex. The glabella is encircled by a distinct furrow; it is smooth, almost gibbous, broadest in the middle, and forming a complete oval, if the neck segment be included: there are no traces of glabella lobes, but the neck furrow is strongly marked.

The cheeks are not half the width of the glabella, steeply bent downwards, and seen without the free cheeks, much narrower forwards than towards the blunt squarish posterior angle. They are confluent in front with a narrow anterior margin. Their posterior side is traversed by the continuation of a deep neck furrow. This furrow runs near the edge at first, but soon diverges, and towards its end turns abruptly upwards to the outer margin of the cheek (fig. 6, *a*). The posterior margin, thus separated, is rendered conspicuous by being, like the glabella, quite smooth, while the rest of the cheek is covered by a lineation parallel to the edge, which also continues round the front.

The facial suture (see figs. 6 and 7) is marginal for a less distance than the width of the glabella in front, then turning downwards in a gentle curve, it crosses the cheek very obliquely, and ends on the *outer* margin at the point where the neck furrow turns up to meet it. There is a slight indentation in it opposite the front end of the glabella, indicating the place of the very forward eyes, but its general course is but very little bent or sigmoid. The free cheeks are absent in all our specimens, but from the shape of the rest of the head, and analogy with similar forms of trilobites, they must have been quite linear, rather broadest in front to complete the half-elliptic form of the head, and attenuated behind. We have restored them, *b*, and indicated the probable position of the small eyes at *c*, in fig. 6.

The thorax is nearly parallel-sided, often partially coiled up, of seven* convex rings, the axis of which is prominent and as broad as the sides, in front rather broader. The sides of the axis in each segment are not sharply defined by a longitudinal furrow, but run out a little into the groove of the pleuræ, as in fig. 6, *d*. These latter are truncate and square at the ends, faceted anteriorly for rolling up, and have the pleural groove very deep, and reaching nearly to the tip, where it ends abruptly; it divides the pleura unequally,—the anterior portion is the largest. The fulcrum is placed at less than half distance from the axis, and from a little beyond this point

* At least in the only specimen (not a full-grown one) which has still the parts *in situ*. One specimen has the appearance of possessing another ring, but it is indistinct.

the pleuræ are bent downwards. The convexity of the body rings, however, though considerable, is much less than half that of the head.

Tail semicircular, the axis is entire and convex; it is marked above, like the thorax joints, by a strong articular furrow, but has no other visible segments; it occupies fully one third the width of the tail, in some specimens more,—and is surrounded by a distinct furrow. The sides are convex to their edge, the upper furrow strong and abruptly terminated; and no others are visible. The axis is smooth, the sides lineated parallel to the margin of the tail.

Variations.—We have not a sufficient number of perfect specimens to ascertain what may be the amount of variation in proportionate width, &c.; but it is evident that some have a longer and wider axis to the tail than others, and this would probably accompany a similar difference in the head and thorax; fig. 4 shows a specimen, full grown, in which the axis is considerably larger than in figs. 2 or 5.

Affinities.—We have already mentioned the close relation this has with the American genus *Triarthrus*, and the relation is perhaps the most intimate in those points in which they differ from the rest of the *Olenidæ*. Indeed were it not for *Triarthrus*, of whose affinity with *Olenus scarabæoides* there can be no doubt, it would have been very difficult to assign a systematic place to this minute and anomalous Crustacean. It has neither the parabolic glabella with its shallow parallel furrows, the long smooth eyes connected to the glabella by an ocular ridge, or the numerous body rings of many *Olenidæ*, but in the shape of the pleuræ, and in the short rounded tail, *Triarthrus* agrees with it, and they are similar too in a peculiar character quite anomalous in the group, viz., that the maxillary portion or free cheek is so reduced in size and length, that the facial suture ends on the *external* margin, and the posterior angle of cheek is turned upward to meet it, and supply its place. Of course in this case there can be no spine to the hinder angle, and thus another usual character of the group is lost. The inflation of the glabella, the minute eye, which does not seem to possess even the usual covering lobe (very distinct in *Triarthrus*), and the few body rings, 7 instead of 16,* fitted much better than *Triarthrus* for coiling up, give so distinct a character that we conceive it to form a very natural genus.

* Hall says 13, but there are as many as 16, exclusive of 4 or 5 in the tail, in a fine specimen presented to us by Dr. Bigsby.

There is one genus, however, to which, though perhaps not identical, our fossil has a very great similarity, we mean *Tiresias*, described by Professor M'Coy, from the head only. The species *T. insculptus*, found also in the Chair of Kildare, differs from ours by its greater size, the glabella pyriform instead of half-egg-shaped, and marked on the sides by two pair of glabella furrows; the posterior angles of the head too are prolonged. But in the general form, lineation of the cheeks, &c., the two are very much alike, and when more specimens are found, it is quite possible that *Cyphoniscus* may be found to be a sub-genus only of *Tiresias*, distinguished by its lobeless glabella and blunt not produced head angles. That genus, like ours, certainly had a minute maxillary portion or free cheek, and judging from the description, the eyes appear to have been also linear and very forward.

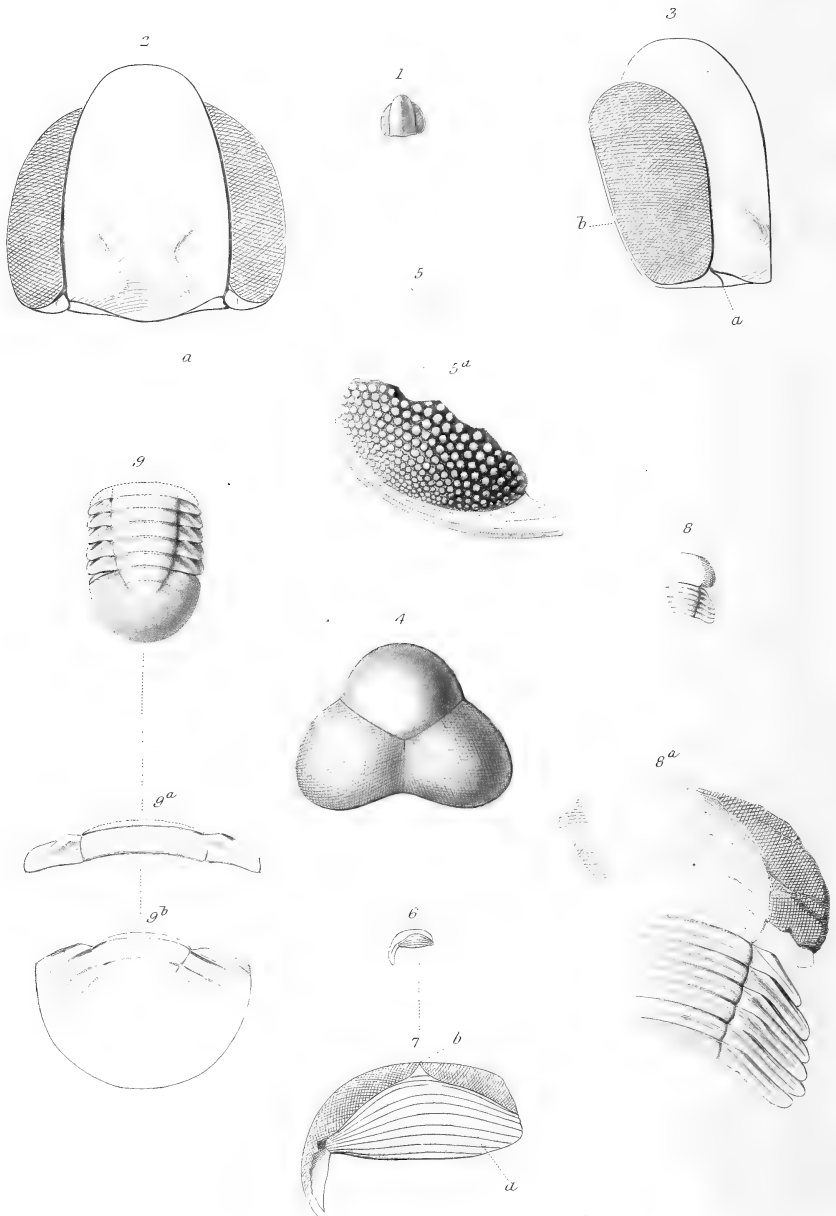
British Localities and Geological Position.—LLANDEILO FLAGS; Limestone of the Chair of Kildare, county of Kildare, Ireland.

EXPLANATION OF PLATE IX.

- Fig. 1. Small specimen, partly coiled.
 Fig. 2. Young individual, with tall and seven thorax joints. In this specimen there is a portion of an eighth segment above the others, but this is probably part of the neck segment.
 Fig. 2*. The same, magnified, the axis of the tail not very large.
 Fig. 3. Young imperfect specimen, seven body rings.
 Fig. 3*. Do., magnified.
 Fig. 4. Full grown head.
 Fig. 5. Full grown tail of a variety with larger axis than usual.
 Fig. 5*. The same, magnified.
 Fig. 6. Magnified figure of the head, two thorax rings, an anterior and posterior one, and tail. At *a*, the neck furrow curves upward, and terminates against the outer margin; *b*, is the restored free cheek (lost in all our specimens); *c*, the position of the eye indicated; *d*, the side part of the axis of the thorax rings, running out into the pleural groove.
 Fig. 7. Lateral view of the head and three first thorax rings; the free cheek and eye are indicated as in the last figure.

J. W. SALTER.

August, 1853.



Figs. 1-7. ÆGLINA MIRABILIS Forbes

8 ——— sp (Æ. MIRABILIS?)—

9 ——— MAJOR — Salter

BRITISH FOSSILS.

DECADE VII. PLATE X. Figs. 1 to 7.

ÆGLINA MIRABILIS.

[Genus ÆGLINA. BARRANDE. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadae.) Body oblong, the extremities equal, rounded; head convex, glabella large, parabolic, not distinctly lobed; eyes very large, occupying the whole or nearly the whole cheek, coarsely granulated (externally?); facial suture ending on the posterior margin close to the axis, no rostral shield; thorax with 5 or 6 rings, the axis broad, the pleuræ faceted and grooved; tail large, the axis of 2 or 3 rings, abbreviated; the sides few-ribbed, or nearly smooth. *Cyclopyge*, CORDA.]

DIAGNOSIS. *Æ. capite gibbo, glabellâ parabolicâ longâ, frontem impendente, et retrorsum lobum cervicalem fere excludente; oculis maximis, totam genam occupantibus, et sub margine glabellæ frontali connatis.*

Æglina mirabilis, FORBES, MSS.

Of all trilobites with eyes, this has the largest and most conspicuous ones, for they cover not only a large part, but the entire side of the head, leaving scarcely a margin. All the species, and there are four or five described, are furnished with these disproportionate organs of vision, but in that which forms the subject of our plate they are more largely developed than in any other, for the two eyes meet in front of the glabella, dividing that portion altogether from the front margin, and occupying therefore the whole length of the facial suture.

The genus was first sufficiently described in M. Barrande's "Notice Préliminaire sur le Système Silurien de Bohême," and is much more fully treated of in his lately published work. Previous to his visit to England, the group was supposed to be a new one; but he kindly showed us in his unpublished figures several forms of this remarkable group, none, however, in which the development of the eyes is carried to such an extravagant degree as in the British species. It is thought better, therefore, to figure so conspicuous a

genus from the materials already acquired, rather than to wait for the chance of finding a perfect specimen.

M. Corda, in his voluminous but most inaccurate work, has given a drawing of this genus under the name of *Cyclopyge*,* in which the large reticulated eyes are mistaken for a granulated glabella, and the facial suture made to travel through the middle of them !

Description.—The head is three lines long by about four wide, very gibbous, almost as deep as broad. The glabella is of a parabolic form, and projects forwards beyond the eyes so as to break the oval contour of the head ; behind it invades the neck segment, and almost obliterates it, leaving only a small portion on each side, which is separated from the glabella by a rather strong furrow. Lobes none, but a short oblique oval indentation on each side occurs at about the lower third of the glabella, the pair of indents being placed as far from the sides as from each other ; a gentle swelling occurs beneath each impression. Some transverse arched striæ run across the base of the glabella, which otherwise appears to be smooth. Eyes very large, and occupying every part of the cheek except the lower inner angle ; they are very convex, and bent round towards the under surface on the sides ; they are still more convex in front, where the two eyes meet and coalesce along a median line, and are there overhung by the gibbous point of the glabella ; they occupy, therefore, the entire length of the facial suture, and quite shut out the usual anterior margin. When the head is viewed on the under side, there is a short triangular space (see fig. 7, b) unoccupied by the lenses, which is a prolongation of the rostral portion ; but except this small space, and the lower corner before mentioned, there is nothing to be seen of the anterior segment but that portion which is on the lower surface. It is not very easy to reckon the number of lenses in the eye, but they are rather large in comparison with *Asaphus* or *Illænus*, and there are not more than 1,100 or 1,200 in each eye. They were probably convex externally (as in *Phacops* and *Cheirurus*), and not covered up by a level cornea ; when they have fallen out, concave pits with prominent interspaces are left upon the cast of the inner surface. The facial suture must of necessity follow the outline of the glabella in this species, and accordingly we have one specimen in which the cheeks, that is the eyes, are absent, and a thin rim only surrounds the glabella. At its posterior termination, however, this suture leaves the inner and lower angle of

* Prodrôme Monogr. Böhm. Trilob. (1847), f. 32. (*Cyclopyge megacephala*, Corda. *Ægle rediviva*, Barr.)

the eye, and cuts the small triangular neck segment in a line which turns obliquely inwards (see fig. 3, *a*). The inner corner, therefore, of this free cheek has a projecting angle inwards, and this has a prominence just at its tip. The under side of the head (fig. 7) shows a flat and rather broad rostral portion of a transversely elliptical shape, pointed at the ends; it is crossed by distant strong sharp-edged striæ, about nine or ten in number.

British Locality and Geological Position.—LLANDEILO FLAGS. Limestone of Portrane, county of Dublin (Coll. Geol. Survey).

EGLINA—SP. Fig. 8.

The specimens from Ireland just described show only the head, and for thorax and tail we have recourse to two specimens from Wales, which are certainly referable to the same genus, but only doubtfully so to the present species. The first (fig. 8), measuring four lines in length, shows the characteristic head and eyes of the genus joined to a thorax of six rings. The segments are narrow in proportion to their width, but this is in part due to slaty cleavage. The axis is not much arched, it is by far broadest in front, where it is two or three times the width of its abbreviated pleura; it is narrower backwards, and the pleuræ on the other hand increase in length; a strong axial furrow separates the wide axis from the sides. The pleuræ are grooved rather more deeply, owing to pressure; they are faceted anteriorly, and have the fulcrum placed at about one third from the axis, from which point they bend a little backwards and downwards. The front pleura is more strongly faceted, more bent back, and has the fulcrum nearer the axis than any of the rest, it is also somewhat wider than the others; all are blunt at the terminations.

The entire thorax in this specimen is equal in length to the head, but this latter part is so imperfect, that we cannot tell whether the glabella was prominent, and divided by a strong sulcus from the eyes; it appears not to have been so, and if this be the case, it must belong to a different species; it is however too imperfect to name.

Locality and Geological Position.—LLANDEILO FLAGS. Black slate underlying the limestones, at Stoneyford, near Haverfordwest, Pembrokeshire; (in company with Graptolites).

The other and more perfect specimen, found in Anglesea, North Wales, is so much larger than the *Æ. mirabilis*, that in the absence

of the head for comparison, we are compelled to regard it as a distinct species. It may be called—

ÆGLINA MAJOR. Fig. 9.

DIAGNOSIS. *Æ. uncialis et ultra, levigata; thorace regulariter convexo, sulcis axialibus haud profundis; axi lato, antice ter, postea bis pleuras superante; pleuris truncatis obtusis, paullum deflexis, fulcro ad tertiam posito; caudâ magnâ, semicirculari, regulariter convexâ nec marginatâ; axi latè conico, ad apicem obscuro, annulis binis; lateribus trisulcosis, sulco antico profundo, reliquis obscuris.*

This specimen has lost the head and first thorax ring.* The remaining portion measures three quarters of an inch in length, by seven lines in breadth, and of this the tail is four and a half lines long, and equal to the thorax. The general convexity is considerable, and equal over all parts; the axis is separated from the pleuræ by a sharp but not deep sulcus, and is broader in front than behind, in the proportion of four to three. The anterior ring being broken off, however, we can only compare the axial portion with the second pleura, and it appears to be rather less than three times its width. The last pleura is half as wide as the axis of that segment. The pleuræ are blunt at their ends, faceted anteriorly, and have the fulcrum placed at one third from the axis, from which point they bend a little backward and downwards with the general convexity. The pleural groove is less deep than in the former specimen, probably because this one has not suffered longitudinal pressure.

The tail is a semicircle, equally and regularly convex, with no raised border. The axis is but very slightly marked, it is broad above, then rapidly narrowing, and soon lost before reaching one third down the tail. One distinct ring is marked off on its upper portion. The sides have the usual faceted external angle, and the equally constant strong upper furrow (which might be called the articulating furrow, being always present in some form or other); below this there is a second much fainter one, at the distance of a thorax segment's breadth, parallel to the upper furrow; and a third closely approximating to the second at its origin, and then diverging downwards. These furrows, except the uppermost one, are faint. The tail is marked in some parts with a transverse lineation, otherwise it is smooth.

* Unless this may be a 5-ringed species, which is quite possible.

Locality and Geological Position.—LLANDEILO FLAGS, (lower portion?) Glan-y-gors, three miles south-east of Llanerchymedd, Anglesea, in nodules among black shale, containing also Graptolites and Lingula.

Affinities.—*Æ. rediviva*, the first described species of this genus, differs from *Æ. mirabilis* by a much broader glabella, and smaller eyes which do not meet in the front; nor is this latter remarkable character known in the other Bohemian species. In other respects, in the tail and six thoracic rings of the same general form, *Æ. rediviva* is very like our species, the axis of the thorax being very wide in front, while the corresponding pleuræ are small; it has also a similar pair of glabella furrows. *Æ. pachycephala* has large but angular eyes, and only five thoracic segments; the other species, *Æ. speciosa*, Corda, does not require comparison.

The affinity of the genus itself is pretty clearly with the Asaphoid group, with which, especially with such forms as Nileus and Illænus it has many points in common. The form of the thorax rings and the smooth almost lobeless glabella are indications of this; and on the under side of the head, the tranverse striated rostral portion strikingly recalls the analogous part of Illænus (see Decade II., pl. 2. fig. 4), although the rostral shield is not separate. The grooved pleuræ, faceted for rolling up, and truncate at their ends, are more like those of Asaphus; and the tail, with its abbreviated axis and few obscure lateral ribs, reminds us of Ogygia Portlockii. Its affinities seem, therefore, more evident with the Asaphoid group than with Bronteus, to which in other respects the genus does not seem very closely allied. But in the extraordinary development of the eyes at the expense of the cheeks, it has no analogue that we know of, except the Remopleurides, as figured in our plate 8 of this Decade. With that group it appears to have no real affinity.

The genus is only yet known in the Lower Silurian rocks.

EXPLANATION OF PLATE X.

- Fig. 1. Perfect head of *Æ. mirabilis*. Portrane; natural size.
 Fig. 2. The same, magnified; at *a*, the small prominences beneath the glabella furrows are seen.
 Fig. 3. The same, side view; at *a*, the posterior termination of the facial suture; *b*, the scarcely perceptible outer margin of the cheek.
 Fig. 4. Front view, showing the large reticulated eyes meeting in front.

Fig. 5. A portion of the lower end of the eye, and inner angle of the free cheek ; same locality.

Fig. 5 *a*. The same, magnified, and showing the convex lenses closely set together.

Fig. 6. Under surface of the head ; same locality.

Fig. 7. The same, magnified ; at *a*, the broad striated rostral shield or clypeus ; *b*, its forward prolongation between the eyes.

Fig. 8. *Æ. sp.* (*Æ. mirabilis?*) from Stoneyford, Haverfordwest ; much distorted and pressed into a shorter form by cleavage ; 6 thorax segments.

Fig. 8 *a*. The same, magnified.

Fig. 9. *Æglina major*. Llanerchymedd, Anglesea ; natural size.

Fig. 9 *a*. Shows the penultimate thorax ring, magnified ; the axis but little more than twice the width of the pleura ; in the anterior ones the axis is wider ; *b*, the tail, similarly magnified.

J. W. SALTER.

August, 1853.

MEMOIRS
OF THE
GEOLOGICAL SURVEY
OF
THE UNITED KINGDOM.

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*Figures and Descriptions*

ILLUSTRATIVE OF  
BRITISH ORGANIC REMAINS.  
—  
DECADE VIII.

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PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

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1855.

PREFACE.

THE dates of the accompanying descriptions by Sir Philip de Malpas Grey Egerton, Bart., have been retained to show when they were respectively completed; but the Decade itself was not published in consequence of a desire of the late Professor Edward Forbes to issue Decade V. at the same time. The appointment of Professor Forbes to the Chair of Natural History in Edinburgh interfered with this arrangement, and a further delay was experienced at his death from the inability to discover the MSS. amongst his papers. The original MS. is now published after having been passed through the press by its author.

H. T. DE LA BECHE.

2nd April 1855.

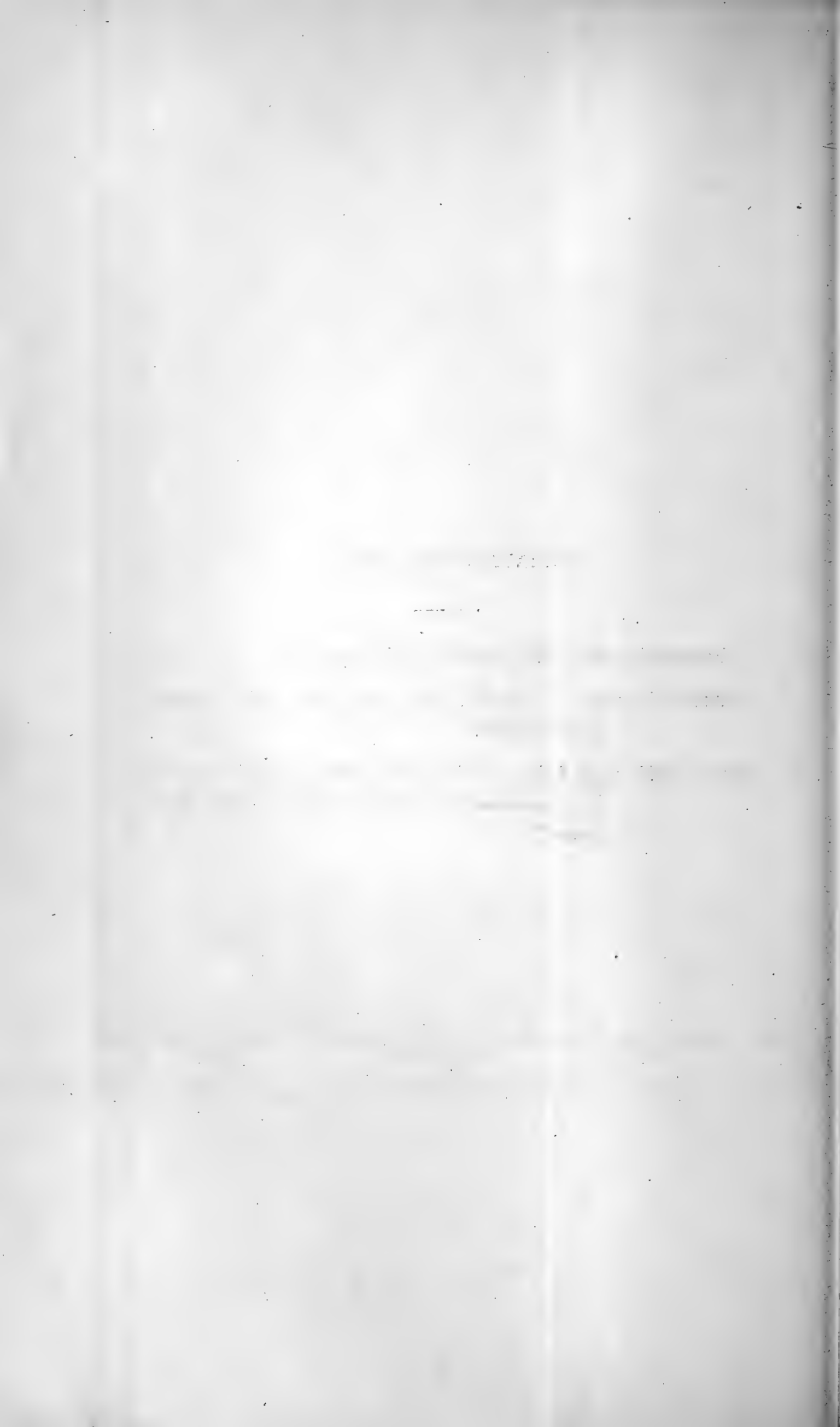


ERRATA IN DECADE VI.

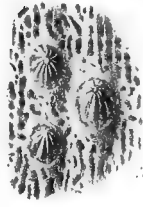
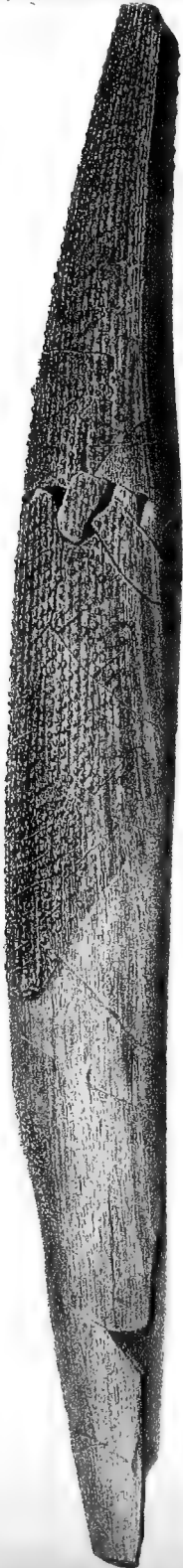
PLATE VI.—*For* “Histionotus” *read* “Ophiopsis.”

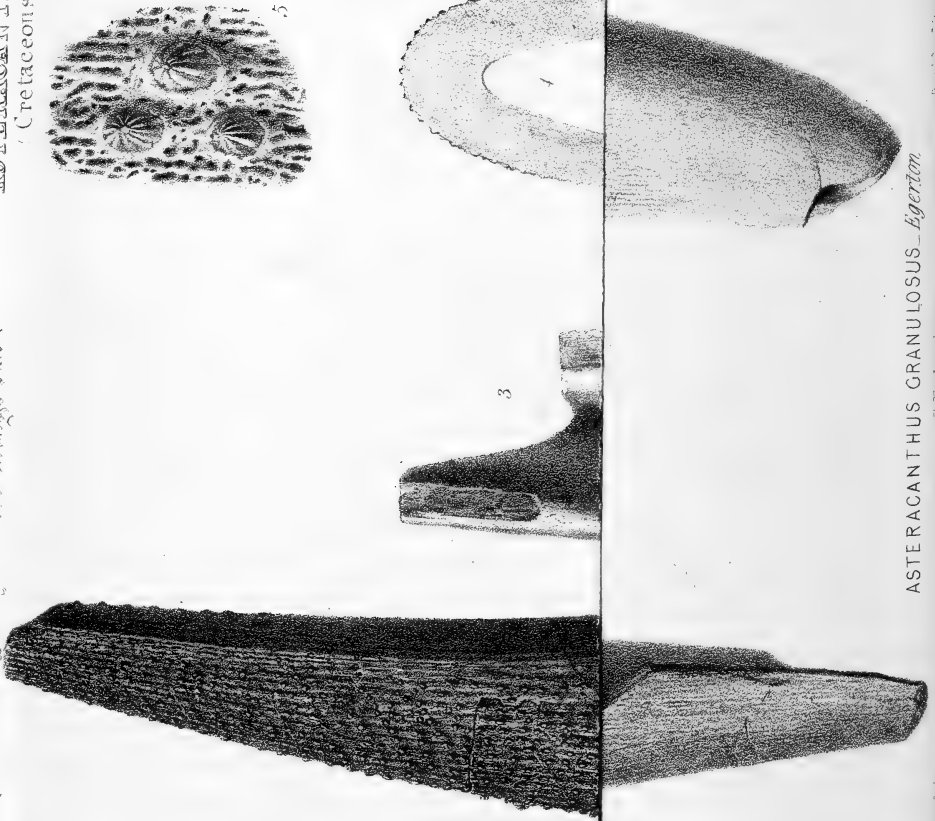
ARTICLE VI., page 1, 21st line from the bottom.—*For* “dorsal”
read “caudal.”

ARTICLE VII., page 2, line 10 from the bottom.—*Omit* “which I
have proposed to remove to the new genus Histio-
notus.”









ASTERACANTHUS GRANULOSUS. *Egerton*

BRITISH FOSSILS.

DECADE VIII. PLATE I.

ASTERACANTHUS GRANULOSUS.

[Genus ASTERACANTHUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Placoidei. Family Cestraciontida.) Dorsal spine large, tuberculate, with a double row of processes on the posterior margin; base smooth.]

Asteracanthus granulatus, Sp. Nov.

Description.—The characters assigned by Professor Agassiz to the genus *Asteracanthus*, are striking, constant, and unmistakeable. The leading features of these Ichthyodorulites are the tubercular surface of the dorsal ray, and the stellate ornament of the tubercles. In the typical species, *Asteracanthus ornatissimus*, found in the Kimmeridge clay, these characteristics attain their maximum development—in the species under consideration, from the Tilgate beds, they are reduced to the minimum. The specimen represented (fig. 1. of the Plate) is the only one approaching a perfect state I have met with. It probably belonged to a young individual. The other figure is taken from a fragment of a much larger ray, in the British Museum, belonging to the same species. The length of the former is nearly 1 foot; when perfect it probably measured an inch more. The base at the front of the ray is only 4 inches in length, but the cavity at the back extends upwards of 8 inches. It is scarcely possible that the whole of this can have been imbedded in the muscles; it is more likely that it supported a large adipose or membranous fin, attached to the hinder surface, and embracing the cavity, but leaving the rough outer part of the bone exposed for offensive or defensive operations. The whole texture of the bone is remarkably coarse and fibrous. It is traversed by inosculating canals, interspersed with pores, arranged in longitudinal series, and showing a reticulated pattern, when examined with a lens. The root and the hinder surface as high as the termination of the cavity are smooth, and free from ornament. The remainder of the ray is covered by numerous smooth tubercles, isolated, but arranged in longitudinal

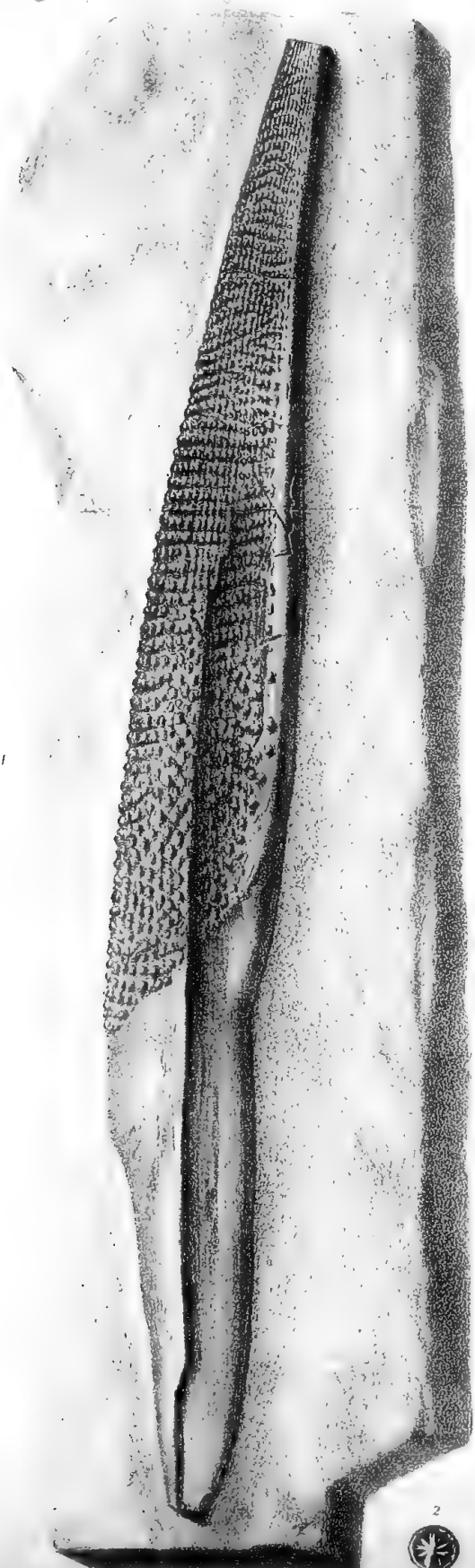
series, parallel to the long axis of the bone. They are smaller in this species than in any other yet discovered, resembling coarse grains of sand; they, nevertheless, have the radiating lines on the apex, so constant in all the *Asteracanthi*. The specimen in the British Museum is a fragment of the lower portion of the ray. It measures 7 inches in length. A second fragment, also in the British Museum, measures 5 inches. In these specimens, as is usual in the rays of full grown individuals of the genus, the asteroids are more distant than in the younger ones. They are small in size, and patelliform in figure, the apex being eccentric, and approaching the upper periphery. Their bases are smooth, the stellate rays becoming obsolete before descending so far. The general outline of the ray is very slightly recurved. The anterior margin is rounded, and without carina. The sides expand considerably, so that the back of the fin is broad, as seen in the transverse section (fig. 4). There is no evidence to lead to any conjecture as to the form of tooth belonging to this species; the only Placoid teeth hitherto discovered in the Tilgate beds being referable to the genera *Hybodus* and *Acrodus*.

Locality.—The original of figure 1. of the Plate is from the ferruginous grit beds of Tilgate forest, and was presented to me by the late Mr. Dixon. The specimen in the British Museum (figs. 2, 3, 4,) is derived, apparently, from the same beds, and formed part of the Mantellian collection.

EXPLANATION OF PLATE.

- Fig. 1. *Asteracanthus granulosus*, size of nature.
- Fig. 2. *Asteracanthus granulosus*, size of nature.
- Fig. 3. Interior of ditto.
- Fig. 4. Transverse section of ditto.
- Fig. 5. Portion of No. 1 magnified.

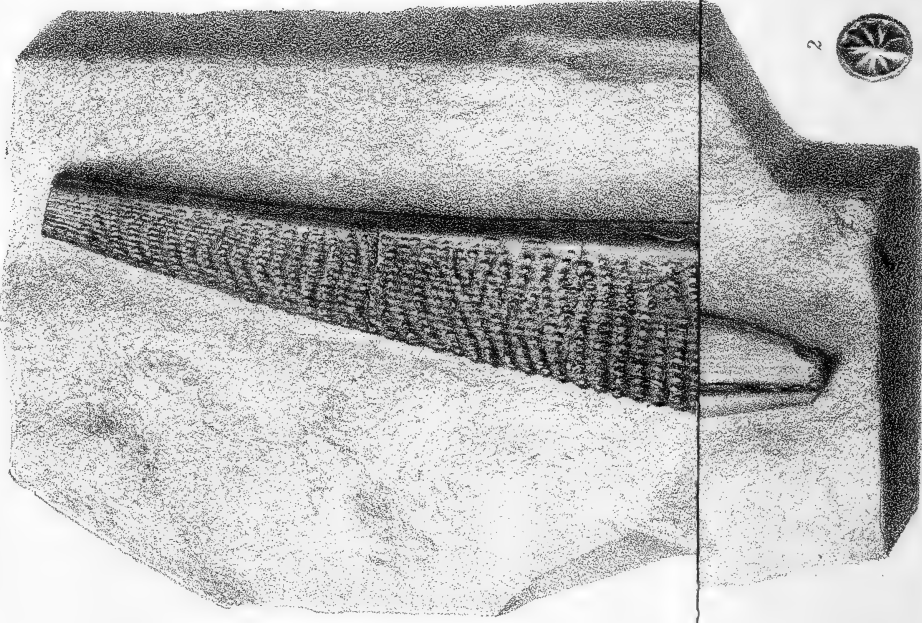




2



ASTERACANTHUS,
Oolitic.



BRITISH FOSSILS.

DECADE VIII. PLATE II.

ASTERACANTHUS VERRUCOSUS.

[Genus ASTERACANTHUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Placoidei. Family Cestraciontidæ.) Dorsal spine large, tuberculate, with a double row of processes on the posterior margin; base smooth.]

Asteracanthus verrucosus, SP. NOV.

Description.—The genus *Asteracanthus*, although for the most part an oolitic form, extends nevertheless upwards into the Tilgate beds, as shown in the preceding article. The typical species, *Asteracanthus ornatissimus*, is a fossil of the Kimmeridge clay. The remarkable character of this Ichthyodorulite attracted the notice of collectors at a very early period. On the 29th of March 1753, a paper, by Mr. Henry Baker, was read before the Royal Society entitled, "An Account of some uncommon Fossil Bodies." This paper is printed in the Philosophical Transactions of the Royal Society for that year. The specimens described and figured are a spine of a *Hybodus*, from Aust Passage, and several examples of the Shotover-hill Asteracanth. The detailed descriptions, as also the representations, are tolerably accurate, but the conclusion drawn is, that "the general appearance of these fossil bodies gives reason to conjecture, that they are bones belonging to the head or snout of some animal of the fish kind, or perhaps of some lizard, alligator, or crocodile." The credit of determining the true nature of these curious fossils is due to Doctor Buckland and Sir Henry De la Beche, who some years ago prepared a joint paper on the subject, which unfortunately was never published. The facts and materials collected by these authors were liberally conceded to Professor Agassiz, when engaged on his valuable publication on Fossil Ichthyology, and he stamps with his authority the correctness of their opinions. The very elegant fossil which forms the subject of this article belongs undoubtedly to the genus *Asteracanthus*, but differs specifically from all those hitherto described. The length of the specimen is $10\frac{1}{2}$ inches, but the apex is wanting to the extent of perhaps $\frac{1}{2}$ an inch. Taking the length as 11 inches, the base of the front of the spine occupies

barely 3, but the cavity on the posterior surface extends for 7 inches. It is, therefore, probable that the membranous fin concealed more of the spine on the back than on the front, a feature found in some of the recent Placoids, with spine-bearing fins. The line of junction between the base and the ornamental portion is less oblique than ordinary, which proves a more erect position of the fin in this than in the other species of the genus. The external surface is closely beset with tubercles, smaller in size and far more numerous than in *Asteracanthus ornatissimus*. They are arranged in very regular longitudinal series, parallel with the front edge of the bone. They become less numerous as they recede from the front, and cease altogether on the posterior margins. The tubercles are oval, the larger diameter coinciding with the direction of the rows; on the distal portion of the spine they become smaller and more elongated. They are all ornamented with deep grooves, radiating (in some instances spirally) from the apex, the stellate surface being of harder material than the base of the tubercle. The substance of the spine bearing these ornamental projections is very coarse and fibrous. The base is also composed of similar material. It has been already stated that the cavity of the spine extends for nearly two thirds of the back aspect; the surface beyond this point, which marks the determination of the cutaneous investment, was armed with a double row of falcate processes, in alternating order, a feature common to other species of the genus. Professor Agassiz conjectures that this form of Ichthyodorulite probably belonged to the genus *Strophodus*, in consequence of the frequent occurrence of teeth of this genus in association with *Asteracanthus* spines, in the Kimmeridge clay of Shotover, and the oolite of Stonesfield. I am not, however, aware that teeth of *Strophodus* have, as yet, been discovered in the Swanage beds.

Locality.—This form of spine is not uncommon in the Purbeck strata of Swanage and the neighbourhood. The specimen I have selected for the figure and description, belongs to the Dorchester Museum, and was, I believe, obtained with many other fine Purbeck fossils from Mr. Wilcox, of Swanage.

Note.—Mr Beckles, of St. Leonards-on-Sea, possesses an Ichthyodorulite, found in the Paludina beds, near Hastings, which varies in some respects from the species described in this article, but it has suffered so much from attrition, that the evidence of specific difference is insufficient.

EXPLANATION OF PLATE.

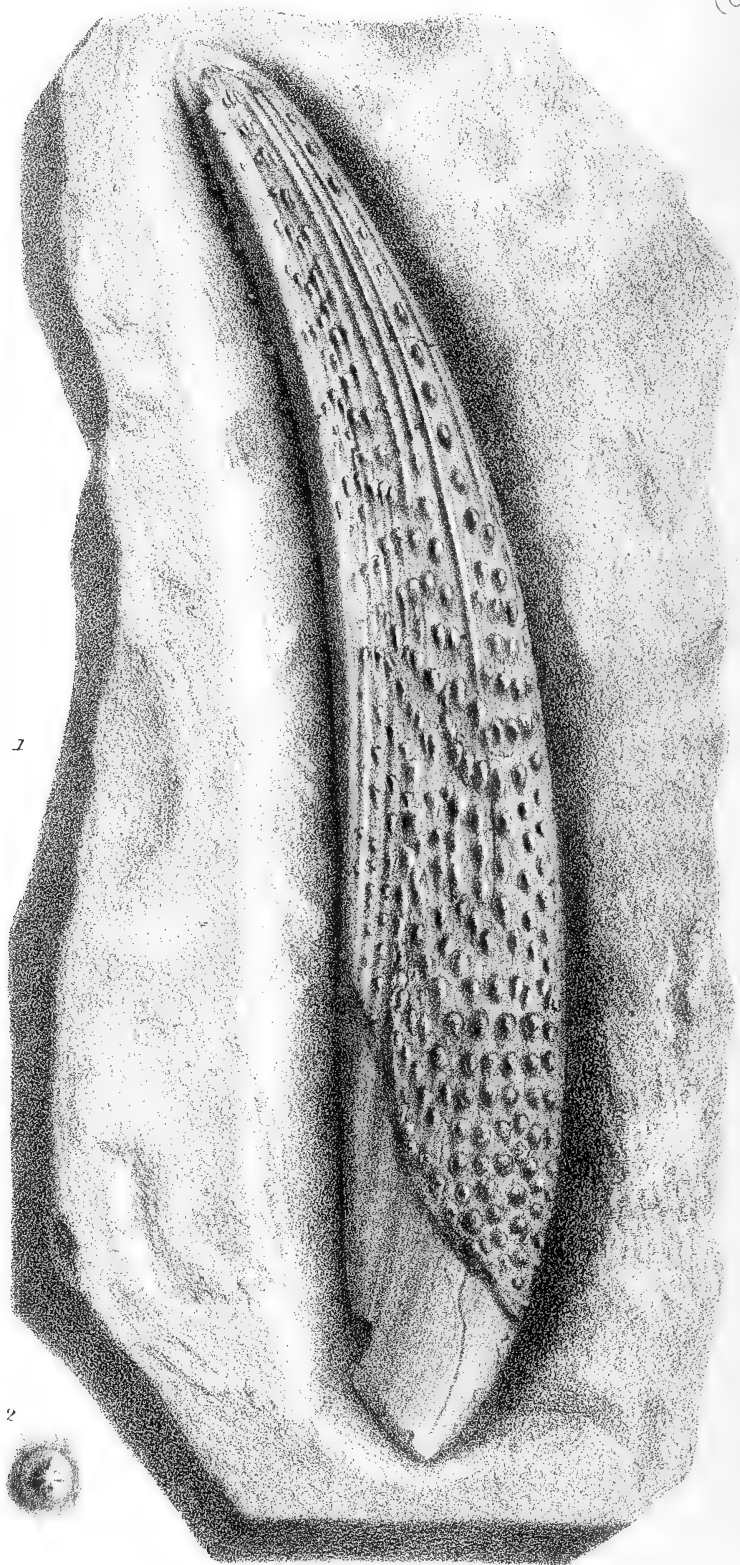
Fig. 1. *Asteracanthus verrucosus*, size of nature.

Fig. 2. Tubercle, magnified.

P. DE. M. GREY EGERTON.

May 1853.





ASTERACANTHUS SEMIVERRUCOSUS — *Egerton*.

BRITISH FOSSILS.

DECADE VIII. PLATE III.

ASTERACANTHUS SEMIVERRUCOSUS.

[Genus ASTERACANTHUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces Order Placoidei. Family Cestraciontidæ.) Dorsal spine large, tuberculate, with a double row of processes on the posterior margin; base smooth.]

Asteracanthus semiverrucosus, SP. NOV.

Description.—This Ichthyodorulite is very distinct from the specimen described in the preceding article, so much so, that I have no hesitation in considering it a new species. Experience has taught us that in those Placoid fishes which had more than one spine, the second dorsal defence differed more or less in form and other peculiarities from the principal one, and thus specimens considered originally as distinct are now recognized as belonging to one and the same species. For instance, *Hybodus curtus*, and *H. reticulatus*, formerly described in the "Poissons Fossiles" as two species, are now shown to have been the first and second dorsal defences of the same fish, and are consequently united under the latter denomination. But there are limits to these variations; and there is, moreover, a general similarity of character, which the experienced eye cannot fail to detect, although to a certain extent disguised by the deviations from a recognized type. In the subject before us there are the strongest evidences of specific difference from *Asteracanthus verrucosus*, as will be seen in the sequel. The specimen is deficient at the point and at the base. The portion remaining measures $7\frac{1}{4}$ inches. If entire, the length would probably have been about 9 inches. The greatest breadth is $1\frac{1}{10}$ inch, from which point the spine contracts very gradually. It is more falcate than any other species of the genus. The anterior face is characterised by a strong carina, which is broken up into tubercles, near the base. The sides of the spine are covered for one half of the entire length with large coarse tubercles, irregularly arranged, and varying both in shape and size. The largest are near the front, these are the

most irregular in shape, some being circular, some elongated longitudinally and others transversely. They are coated with a hard enamelloid substance, sculptured with a few radiating sulci. The tubercles decrease in size on approaching the posterior edge, and become obsolete before they reach it. The hinder rows are more regularly arranged than the anterior ones, forming lines parallel to the back of the spine. On the upper half the tubercles retain the same characters, but are fewer in number and more scattered. They are also intermixed with continuous ridges, similar to those ornamenting the rays of the *Hybodi*. Some of them are undulating on the edge, as if they resulted from the confluence of a row of tubercles. The angle formed by the junction of the lateral and posterior planes is slightly obtuse on the distal portion, but becomes nearly a right angle at the base. The posterior plane is furnished with a few coarse processes near the point. The root of the spine, and indeed the whole of the surface unoccupied by the superficial ornament, is composed of coarse fibrous bone. The line of demarcation between the external and inserted portions of the spine is very oblique, more so than in any other species. These characters, well shown by Mr. Dinkel, in the lithograph representation, serve to distinguish this from all the members of this genus hitherto described.

Affinities.—The irregular arrangement of the tubercles on the sides of this spine is found in *Asteracanthus Preussi* (Dunker),* but the latter differs in every other respect. Of the rays described by Professor Agassiz, *Asteracanthus acutus* is certainly the nearest ally of this species. It is distinguished from it by a more tapering form, the smaller size and more regular disposition of the tubercles, and by the greater number of defensive processes on the posterior surface. The *Asteracanthus semisulcatus* of Agassiz, has some resemblance to it in the admixture of ribs with the tubercles, but in other respects it is very distinct. In describing the latter species, Agassiz surmises it to be identical with the *Ichthyodorulites Purbeckensis* of Buckland and De la Beche, but as it is a fossil very characteristic of the Stonesfield oolite, I am inclined to think the Purbeck specimen seen by the latter authors may with more probability be assigned to the species described in this article. In addition to the three new British species of *Asteracanthus* described in this Decade, I have a specimen of distinct character from the Caen limestone. It is a short, thick spine, densely covered with coarse

* Palæontographica, vol. i. p. 188.

stellate tubercles, each of which is supported on a circular, smooth base or pedestal. I have named it *Asteracanthus papillosus*.

Locality.—The only specimen I have seen of this species is one from Swanage, presented to the Dorchester Museum by Mr. Williams, and liberally placed at my disposal, for description, by that institution.

EXPLANATION OF PLATE.

Fig. 1. *Asteracanthus semiverrucosus*, size of nature.

Fig. 2. Tubercle, magnified.

P. DE M. GREY EGERTON.

May 1853.

CHAPTER IV

The first part of the chapter discusses the importance of maintaining accurate records of all transactions. It is essential for the business to have a clear and concise record of its financial activities, as this will enable it to determine its true financial position at any time. The records should be kept in a safe and secure place, and should be accessible to all concerned parties.

The second part of the chapter deals with the various methods of accounting. It discusses the different systems of bookkeeping, and the advantages and disadvantages of each. It also explains the importance of using a double-entry system, and how to set up a ledger.

The third part of the chapter covers the various types of accounts that a business should maintain. It discusses the different classes of assets, liabilities, and equity, and how to record transactions in each of these accounts. It also explains the importance of using a trial balance to check the accuracy of the books.

The fourth part of the chapter discusses the various methods of valuing inventory. It explains the different methods of valuation, and the advantages and disadvantages of each. It also discusses the importance of using a consistent method of valuation, and how to adjust the books for changes in inventory value.

The fifth part of the chapter covers the various methods of depreciation. It explains the different methods of depreciation, and the advantages and disadvantages of each. It also discusses the importance of using a consistent method of depreciation, and how to adjust the books for changes in depreciation value.

The sixth part of the chapter discusses the various methods of determining the cost of goods sold. It explains the different methods of cost determination, and the advantages and disadvantages of each. It also discusses the importance of using a consistent method of cost determination, and how to adjust the books for changes in cost.

The seventh part of the chapter covers the various methods of determining the net income of a business. It explains the different methods of net income determination, and the advantages and disadvantages of each. It also discusses the importance of using a consistent method of net income determination, and how to adjust the books for changes in net income.





PHOLIDOPHORUS GRANULATUS — Egerton.

F. P. P. P. P. P.

BRITISH FOSSILS.

DECADE VIII. PLATE IV

PHOLIDOPHORUS GRANULATUS.

[Genus PHOLIDOPHORUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Lepidostei. Sub-family Lepidostei homocerci. 2d Group. Body elongated, more or less fusiform.) Dorsal fin small, opposite the ventrals; caudal fin forked; the lobes equal; the base of the upper lobe invested with scales: teeth villiform.]*

Pholidophorus granulatus, Sp. Nov.

Description.—The genus *Pholidophorus* makes its first appearance during the deposition of the lias, and contributes some of the most characteristic forms of the fauna of that period. No less than fifteen species are named and described from that formation alone. The succeeding members of the oolitic period in Great Britain are singularly deficient in species of this genus as compared with the continental deposits of corresponding age; for of the nineteen oolitic species enumerated by Professor Agassiz in the “Poissons Fossiles,” only one, *Pholidophorus Flesheri*, occurs in England. The more recent deposits have only furnished one species, the *Pholidophorus ornatus* of the Purbeck strata of Swanage. The single specimen examined by Agassiz, and consequently the type of the species, is a mere fragment, formerly belonging to the late Doctor Mantell, but now in the collection of the British Museum. On comparing this, the original, with the representation given in the “Poissons Fossiles,” an error becomes manifest in the position of the dorsal fin. The impressions of some broken scales in the neighbourhood of the tail have been mistaken for the rays of the dorsal, and this character has been embodied in the text as distinctive of the species, whereas the true rays of the dorsal fin are traceable in the position which usually obtains in the *Pholidophori*, viz., the middle of the back. The peculiar character of the scales is, however,

* Poiss. Foss. vol. 2, p. 9.

sufficient to distinguish the species from all others. Very fine specimens have recently been found which prove this character to be constant and uniform; so much so, that a single scale could at once be recognized without fear of error. The subject of this article constitutes a second species, also from Swanage, and more nearly allied to *Pholidophorus ornatus* than to any other species. The distinctive feature most easily appreciable is the greater depth of the body as compared with the length; there are also differences in the form and ornamentation of the scales, which will be described in the sequel. The specimen selected for representation measures $6\frac{1}{2}$ inches from the snout to the commencement of the tail. The depth of the body from the anterior limb of the dorsal fin to the insertion of the ventral fin, is $2\frac{3}{4}$ inches; and from the nape to the insertion of the pectoral fin, 2 inches. These relative dimensions in a specimen of *Pholidophorus ornatus*, 6 inches in length, are only $1\frac{1}{2}$ inch for the former, and $1\frac{1}{4}$ inch for the latter, a difference too remarkable to be attributed either to sexual peculiarities or to accidental circumstances. The head measures $1\frac{1}{2}$ inch in length, and $1\frac{3}{4}$ in depth, while in the allied species these dimensions are reversed, the length being greater than the depth. The bones of the head are prettily ornamented with groups of granules arranged in a variety of patterns. They are most numerous on the frontals and pre-frontals. This granular character occurs also on the branchiostegous rays, the opercular flap, and the scales extending from the occiput to the dorsal fin. The operculum is of moderate size, but the sub-operculum is enormously developed in the vertical direction. The granular character is less prominent on these bones than on the other parts of the head. The dorsal fin is placed nearer the head than is the case in *Pholidophorus ornatus*. It is composed of about a dozen rays, of which the first four are short and single, the remaining ones broad with frequent transverse articulations, and bifurcate extremities. The pectoral fins are of moderate size, and contain about 18 rays, all slender except the first, which is thick and strong. The distance between these and the ventral fins is less than in *Pholidophorus ornatus*. The latter organs contain each from 10 to 12 rays. The exterior one has an ornamental border of oblique osselets, the succeeding ones are stronger than those of the pectoral fin, and have few transverse articulations, these being restricted to the distal, bifurcate, extremities. The anal fin is equidistant from the insertion of the ventrals and the commencement of the tail. Only a trace of it remains. The caudal fin is also deficient. The lateral line is nearly horizontal. The scales

it traverses are large and fan-shaped. The surface of these scales is covered with distinct striations radiating symmetrically from the central line, and about 24 in number, 12 above the lateral line and 12 below it. In the scales above and below this principal series, the striæ are more divergent and oblique on the lower part of the scales than on the upper. On the back, and occasionally in other parts, the striæ are intermixed with fine granulations. The posterior edges of the scales are serrated. The scales in *Pholidophorus ornatus* have the striations less numerous, coarser, and less divergent; and the posterior edges are more deeply notched. The scales on the back and belly in both species are considerably smaller than those on the flanks.

Locality.—This species was procured at the Swanage quarries by Mr. Wilcox, and transferred with his collection to the Dorchester Museum.

EXPLANATION OF PLATE.

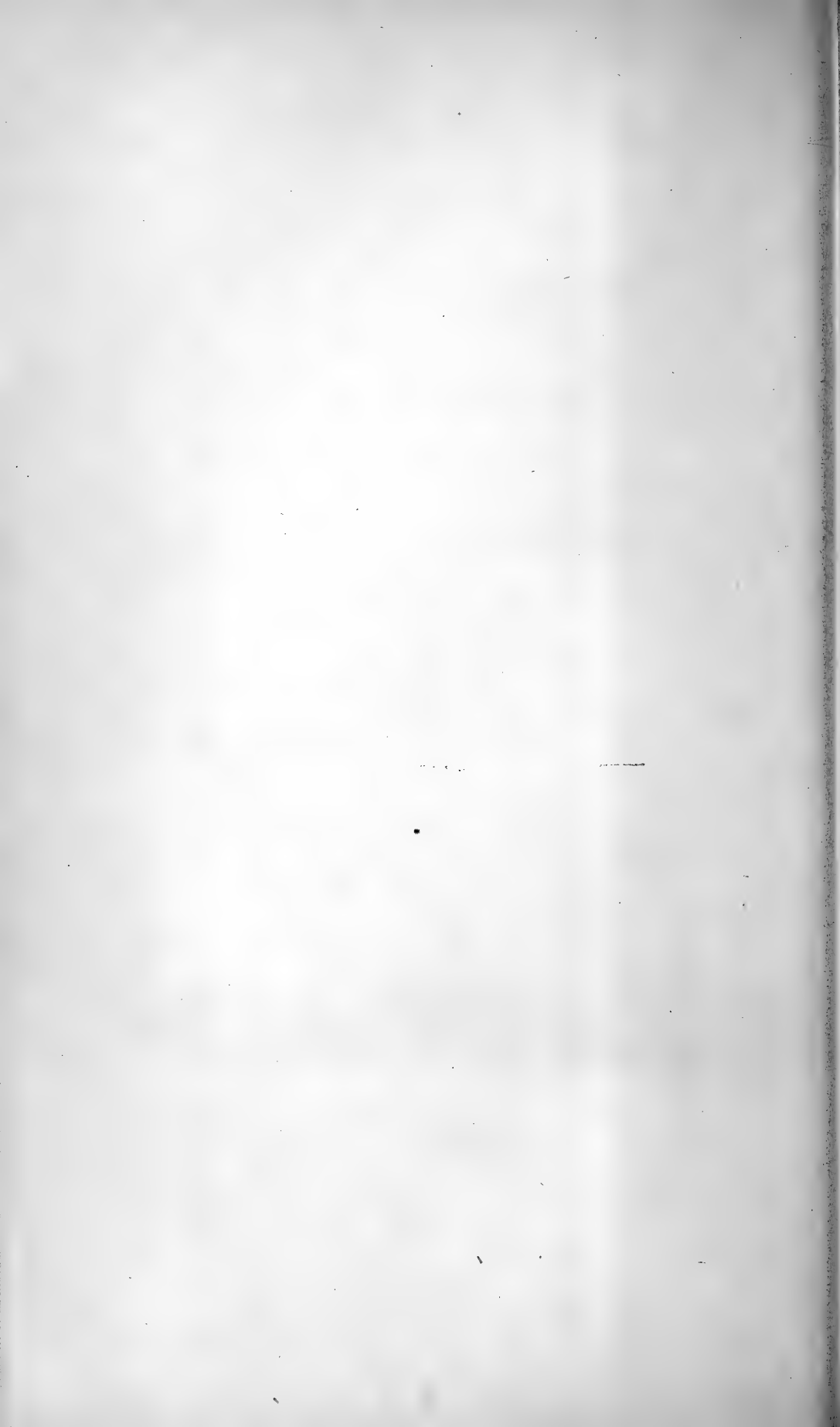
Fig. 1. *Pholidophorus granulatus*, size of nature.

Fig. 2. Scales magnified.

Fig. 3. Scales of *Pholidophorus ornatus*, magnified.

P. DE M. GREY EGERTON.

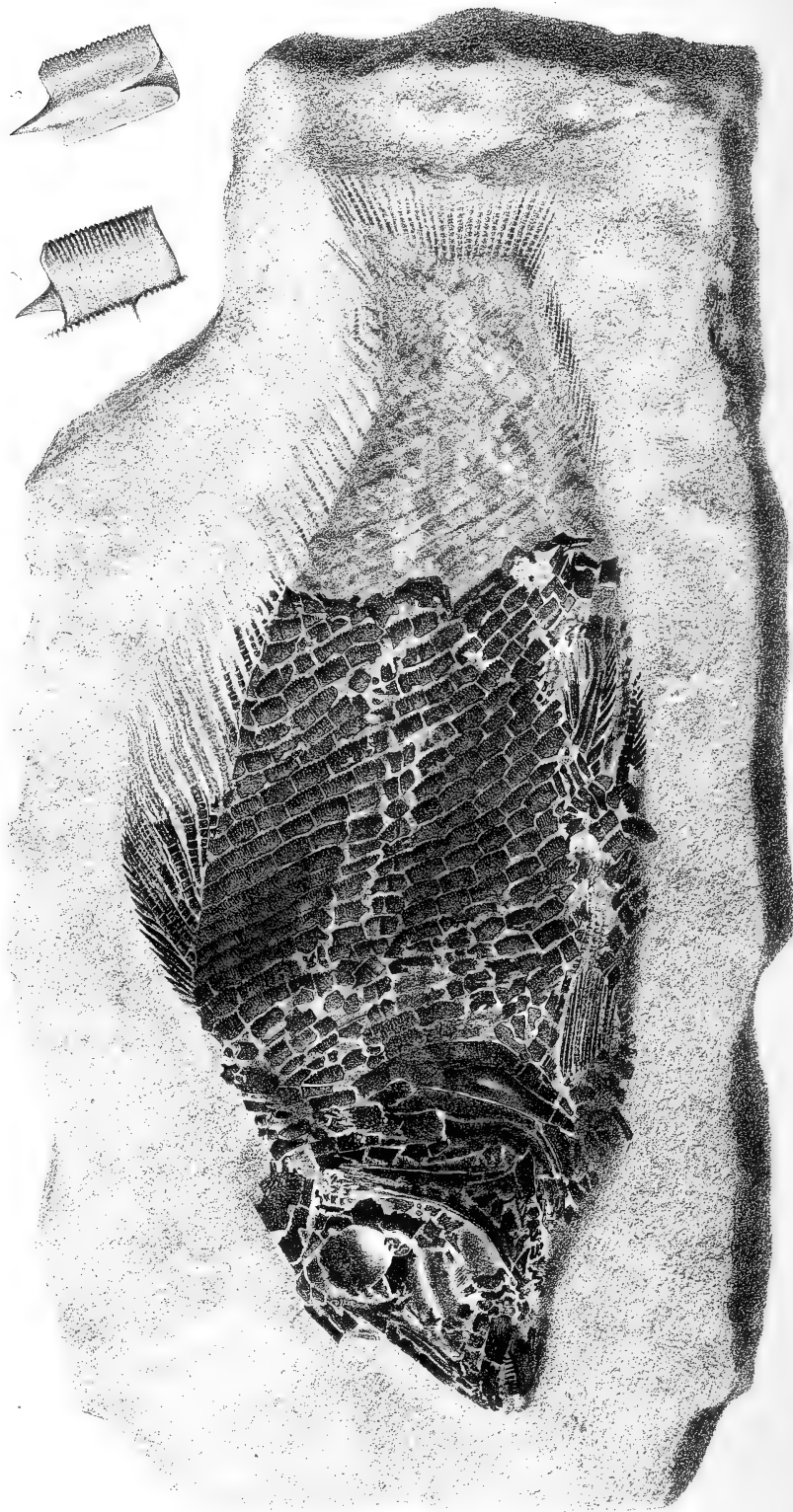
July 1853.





HISTIONOTUS
(OCTIPETIC)

1



HISTIONOTUS ANGULARIS — Egerton.

F. Forbes delin.

W. Dalziel sculp.

Printed and Published by Day & Son, Lithographers to the Queen.

BRITISH FOSSILS.

DECADE VIII. PLATE V.

HISTIONOTUS. GEN. NOV.

[Genus HISTIONOTUS (*ιστιον*, a sail, and *νωτος*, the back). EGERTON. Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Lepidostei. Sub-family Lepidostei homocerci. 2d Group. Body elongated, more or less fusiform.) Dorsal fin commencing behind the nape and extending to the tail; teeth elongated; scales serrated, articulated as in *Pholidophorus*.]

Histionotus angularis. SP. NOV.

Description.—The subject of this article presents a more remarkable combination of characters than any fossil fish with which I am acquainted. It has the head and tail of a *Lepidotus*, the dorsal fin of an *Ophiopsis*, the scales characteristic of the genus *Pholidophorus* and the form of a *Semionotus*. At the same time it differs so essentially from each of these genera, that it can be assigned to none of them. The generic title I have adopted records its most emblematic feature, the dorsal fin. The specimen figured in the accompanying plate, (the only one of which I am at present cognizant, with the exception of an imperfect one in the Museum of Practical Geology,) measures 6 inches from the nose to the commencement of the caudal fin, the head occupying about one third of the entire length. The greatest depth, $2\frac{1}{4}$ inches, occurs at the point of commencement of the dorsal fin. The outline of the head very much resembles that of *Lepidotus minor* in the rapid declination of the frontal bones and the prognathic character of the jaws. The interior of the mouth is not visible; it is impossible, therefore, to determine whether it was furnished with supplementary teeth, as in *Lepidotus* and *Semionotus*, or with a single row, as in *Pholidophorus*. The principal series is well displayed; the teeth composing it are very uniform in size and shape; they are straight elongated cones with blunt apices, and quite smooth on the surface; nearly resembling the outer teeth in some of the slender-toothed *Lepidoti*; the pre-operculum is unusually strong and very rugged

on the surface. The other opercular bones are high and narrow; they are covered superficially with flattened imbricated scales of ganoine. The coracoid bone is broad and flattened out posteriorly. The superficial ornament is uniform with that on the opercular bones. The rays composing the pectoral fins are long, and the transverse articulations near their extremities are very numerous; they are about 12 in number. No fulcral rays appear to have been present in these fins. The ventral fins are situated rather behind the centre of the body. They are of moderate size, and have several strong elongated scales on their anterior margins. The impression alone of the anal fin is preserved. This shows it to have been of considerable size, and to have extended very far back, almost to the commencement of the caudal fin. The latter fin is also, for the most part, deficient in the specimen, although enough is seen to prove its resemblance to this organ in *Lepidotus*. The most remarkable feature in this fish is the dorsal fin. It originates about half an inch behind the occiput, and extends from thence without interruption to the commencement of the lobe of the tail. The outline of the back is also very peculiar in this fish. It rises rather abruptly from the head to the dorsal fin, it then declines gradually for about 2 inches, and thence slopes suddenly to the tail. In lieu therefore of the graceful sweeping form which generally prevails in this family, we have a somewhat angular outline of back, which, together with the prominent snout, has suggested the specific name. The dorsal fin is fortified by a set of fulcral scales and spines on its anterior margin, but these are by no means so strongly developed as in the species of *Lepidotus* most nearly allied to this genus. The fin rays are thick, they bifurcate at a short distance from their base, and are thence traversed by numerous approximate transverse divisions. Before the point of bifurcation these articulations are few. It is impossible to count the number of the rays, as the fin is by no means perfect, they cannot, however be computed at fewer than 40. The scales are very uniform in size and shape in all parts of the body, except in the vicinity of the tail. The exposed surface is rhomboidal, the vertical axis being the longest. The angles vary but slightly from right angles. The upper posterior ones being slightly acute, the lines of union between the scales in the dorso-ventral series are oblique to the longitudinal axis of the body; the more so from the direction of the series themselves being at a considerable angle downwards and backwards. There are from twelve to fourteen scales in each series. The lateral line is nearly straight; it occupies the sixth row of scales in descending

order from the back. The surface of all the scales is smooth on the anterior portions. The posterior margins are finely serrated, and the surface of the scale in the vicinity of the serrations is finely striated; the striæ agree in number with the serrations, being due to the persistence of the marginal serrations of earlier periods of growth. The scales are united by long processes on the under-surfaces, very similar to the corresponding parts of the scales of *Pholidophorus*, and differing entirely from those of *Lepidotus* or *Ophiopsis*.

Affinities.—The affinities of the genus *Histionotus* have been considered at the commencement of this article. I would only add that, on the whole, it seems to be more nearly allied to *Pholidophorus* than to any other genus. It may, perhaps, hereafter be thought advisable to remove to this genus some of the fishes with long dorsal fins now grouped with the *Pholidophori*, rather than to the genus *Ophiopsis*, as suggested in the description of *Ophiopsis breviceps* in the Sixth Decade.

Locality.—The specimen described above, and figured in the accompanying plate, was procured by me in the course of the present year from one of the quarries of Purbeck stone at Swanage.

EXPLANATION OF PLATE.

Fig. 1. *Histionotus angularis*, size of nature.

Fig. 2. Scales, magnified.

Fig. 3. Under surface of scale, magnified.

P. DE M. GREY EGERTON.

May 1853.

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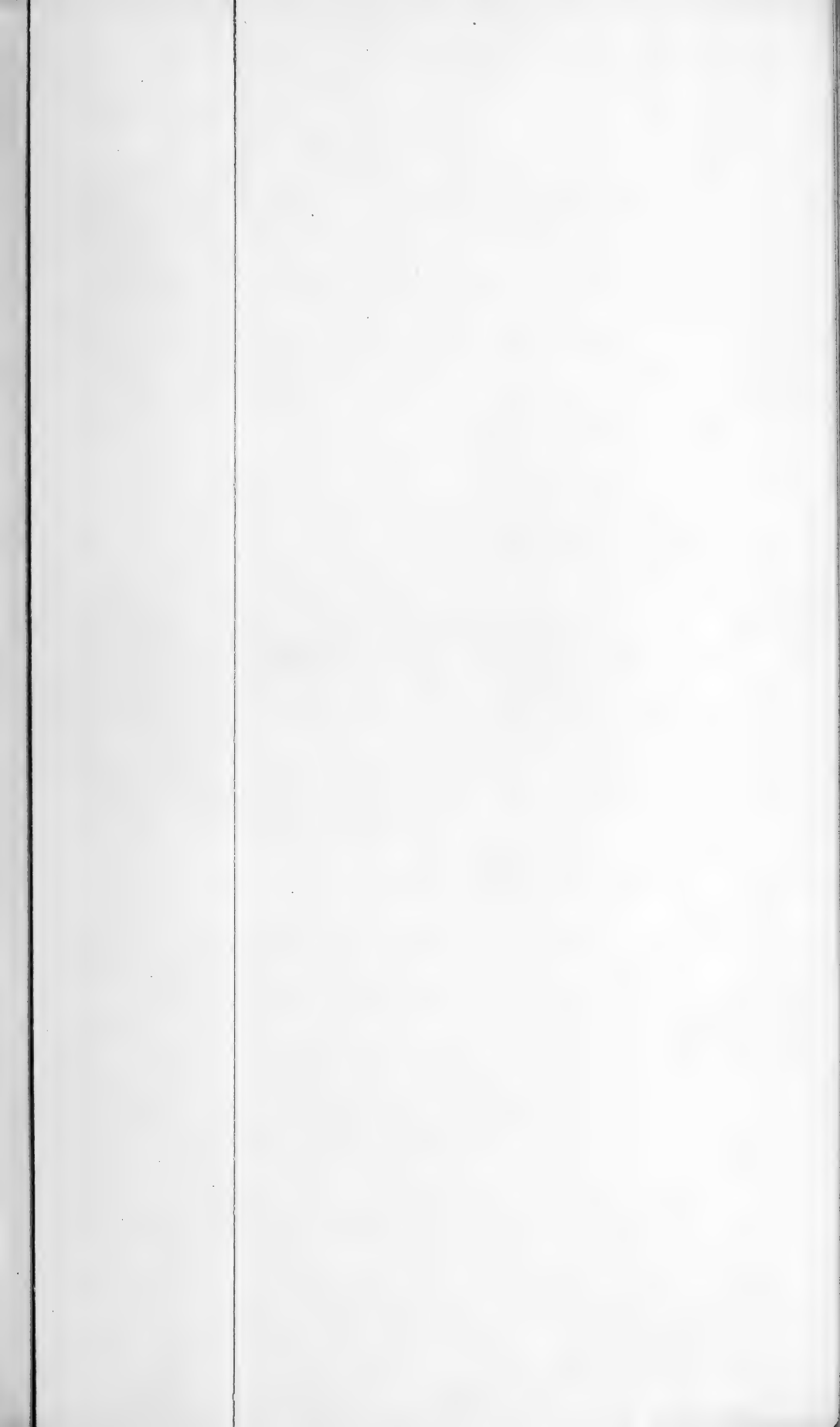
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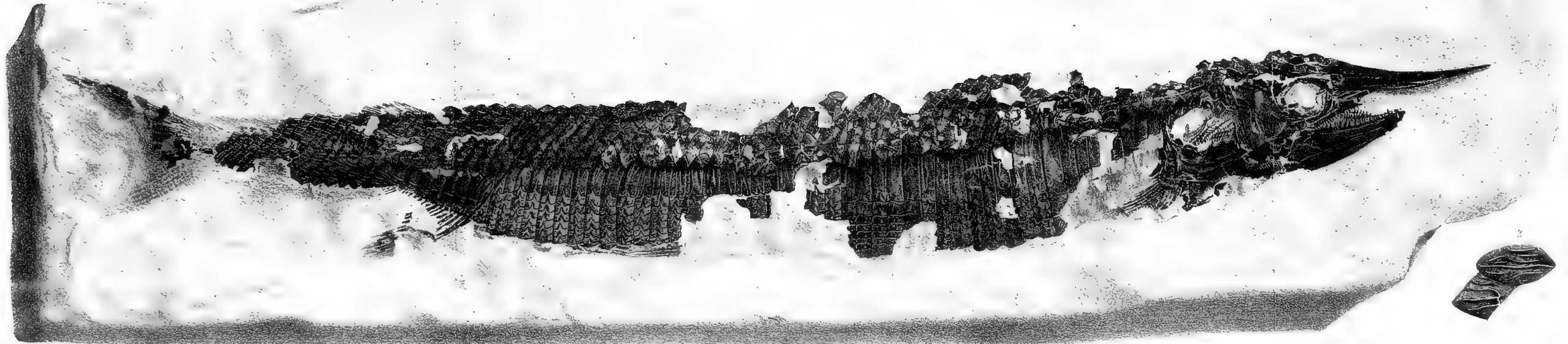
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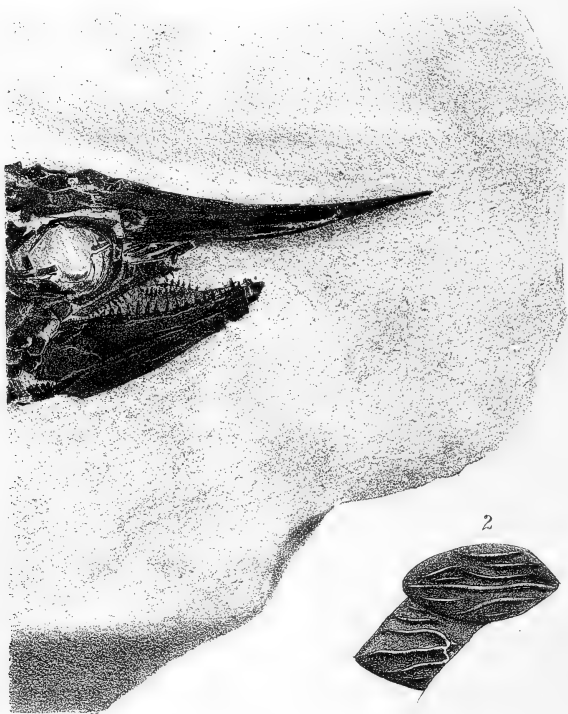
PLATE 6. 11. 6.
ASPIDORHYNCHUS FISHER,
Oolithes.



ASPIDORHYNCHUS FISHER *Fisher*

Scale of Oolithes.

DECADE 6 PL 6.
ASPIDORHYNCHUS.
(Oolite)



Day & Son, Lith^{rs} to The Queen.

BRITISH FOSSILS.

DECADE VIII. PLATE VI.

ASPIDORHYNCHUS FISHERI.

[Genus ASPIDORHYNCHUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniopodoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st Group. Tail forked.) Body much elongated; upper jaw produced in the form of a beak; pectoral and ventral fins rounded; dorsal fin far back and opposite the middle part of the anal fin; tail forked; scales higher than wide, especially in the middle part of the body; teeth extending in the upper jaw beyond the point of the lower jaw.]*

Aspidorhynchus Fisheri. Sp. Nov.

Description.—Three species only of this genus are figured and described by Professor Agassiz in the “Poissons Fossiles.” In addition to these, six others are named and briefly noticed. The characters of all these are well known to me, with the exception of *Aspidorhynchus Walchneri*, a fossil of the lias of the Oberland Badois; of which I have never seen a fragment. As no information is given with respect to this fish, and as it is not likely that it can be identical with a Purbeck species, it will be omitted in considering the subject before us. Of the eight remaining species, five are from the oolites of Solenhofen and Kelheim; one from the lias of Whitby; one from the Oxford clay of Christian Malford; and one from Barra do Jardim in Brazil, from a stratum probably about the age of the Green Sand. The subject of this article, a fish of the Purbeck beds, differs in many respects from all the species alluded to by Agassiz, and possesses individual features so clear and distinctive, that it would be superfluous to enter at length into a description of the agreements and discrepancies existing between it and the other members of the genus. A simple enumeration of the characters of the species will suffice to establish it without risk of confusion. In form and proportions, it holds an intermediate position between *Aspidorhynchus acutirostris* and *Aspidorhynchus mandibularis*,

* Poiss. Foss. vol. ii. page 14.

being more slender than the former, and less so than the latter. In general appearance it is not unlike the common *Belone* of our British seas. The specimen selected for description has been kindly lent for that purpose by the authorities of the Dorchester Museum. It measures 13 inches from the snout to the base of the caudal fin, and $1\frac{3}{4}$ inch in depth at its greatest diameter. The head measures $3\frac{3}{10}$ inches in length; nearly 1 inch of this measurement being due to the prolongation of the rostrum beyond the symphysis of the lower jaw. This portion of the snout is characterized by deep longitudinal striæ, while the base is perfectly smooth. The surface of the cranial bones, but more especially of the prefrontals, is studded with small granules interspersed with ridges of enamel grouped together in an elegant pattern, and arranged for the most part in a longitudinal direction. The lower jaw has a single row of small close set tubercles on its median line. In advance of the blunted extremity of the symphysis of the rami, a single, solid, conical osselet is articulated, forming the apex of the lower jaw. This peculiar structure is common to all the species of *Aspidorhynchus*, but does not, so far as I am aware, occur in any other genus. The orbit is large, and situated near the angle of the jaws. The latter are furnished with a formidable array of sharp incurved teeth. Those of the lower mandible appear in the specimen figured to have been the largest; but a portion of an upper jaw in my possession leads me to conclude that the armature of the upper maxillary bone was not at all inferior in power to that of the lower maxillary. All the teeth appear to be quite smooth. The opercular apparatus is defective. The operculum is wanting, but owing to this, perhaps lucky, accident, the bronchial arches are exhibited; parts rarely preserved in the fossil state. The sub-operculum is small, and apparently smooth. The pre-operculum, on the contrary, is large, and ornamented on its lower limb with a row of distinct plaits of enamel. The posterior angle is nearly a right angle. The pectoral fins are much mutilated; they appear to have been small, and to have been supported by a feeble thoracic arch. The ventral fins are also much broken. They are situated 8 inches from the snout, and 5 from the tail. The rays composing them are broad, and the transverse articulations are numerous. The anal fin is inserted $2\frac{3}{4}$ inches from the base of the caudal fin. The anterior rays are long, and bifurcated at their extremities, but the succeeding ones decrease rapidly in length, giving a slender and pointed character to the fin. The number of rays is uncertain, but they seem to have been not fewer than 14 or 15. The dorsal is the most remote of all the fins, its origin being

only 2 inches from the commencement of the tail. This backward position of the dorsal fin is a feature found in all the *Aspidorhynchi*, but in the species under description it obtains its maximum eccentricity. The scales are for the most part exposed on their under-surface. The principal series, or that traversing the middle of the flank, is composed of scales about half an inch in depth. This is succeeded above and below by several series of much smaller dimensions. The substance of all the scales is thinner than in any of the oolitic species, and the articulating rib on the inner face is less prominent. The outer surface of the scales, with the exception of those along the back of the fish, is smooth and devoid of ornament. The dorsal series, however, is characterised by strongly marked crests of enamel, arranged in continuous lines in the longitudinal direction of the scales. These ridges are most prominent in front of the dorsal fin. The tail is slender and deeply forked, forming an appropriate finish to the graceful outlines of this, one of the most elegant denizens of the waters in which it lived.

Locality.—The Dorchester Museum possesses two specimens of this rare fish, procured by Mr. Wilcox, of Swanage, from the quarries of Purbeck stone in that vicinity. I have named it in compliment to the Rev. Osmund Fisher, owing to whose exertions the town of Dorchester is in possession of a very thriving museum, and through whose kindness I have had the opportunity of examining all the valuable materials in that depository.

EXPLANATION OF PLATE.

Fig. 1. *Aspidorhynchus* Fisheri, size of nature.

Fig. 2. Dorsal scales, magnified.

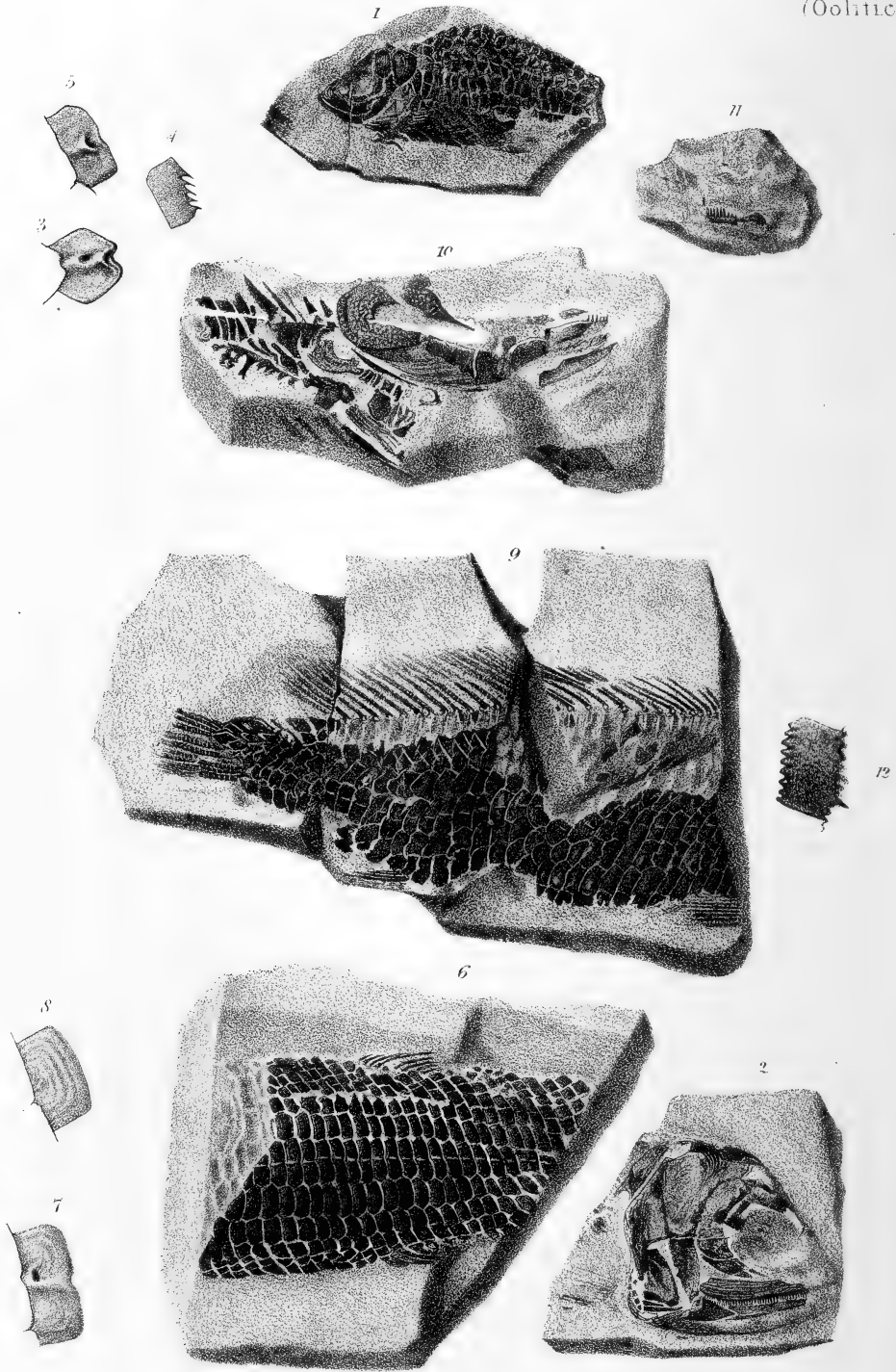
P. DE M. GREY EGERTON.

June 1853.





PHOLIDOPHORUS
LEGNONOTUS.
(Oolitic)



1-5. PHOLIDOPHORUS HIGGINSI—Stutchbury 9-12 LEGNONOTUS COTHAMENSIS—Egerton.
6-8 PHOLIDOPHORUS NITIDUS —Egerton.

BRITISH FOSSILS.

DECADE VIII. PLATE VII.

FIGS. 1—5.

PHOLIDOPHORUS HIGGINSI.

[Genus PHOLIDOPHORUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces Order Gonirolepidoti. Family Lepidostei. Sub-family Lepidostei homocerci. 2d Group. Body elongated, more or less fusiform.) Dorsal fin small, opposite the ventrals; caudal fin forked; the lobes equal; the base of the upper lobe invested with scales; teeth villiform.]

SYNONYM.—*Pholidophorus Higginsi*. STUTCHBURY.

Description.—This diminutive member of the genus *Pholidophorus* was named by Mr. Stutchbury, of the Bristol Institution, in compliment to the discoverer; but as no figure or description of the species has yet been published, I have selected it as an appropriate subject for this Decade. It is one of the smallest species of the genus; the largest of all the specimens hitherto found not exceeding 2 inches in length. It is remarkable also for the large size and great solidity of the scales. The specimen I have selected for representation is not so complete as some others, but it gives the best idea of the form and characters of the head and scales, features which are for the most part either crushed or deficient in the other examples. It differs remarkably from the other small *Pholidophori* in the thick and short-set proportions of the body, in which respect it contrasts strongly with the elegant outlines of *Pholidophorus gracilis* of Count Münster—the smallest species hitherto described. The head measures rather less than one third of the entire length, and is about equal to the largest diameter of the body. The muzzle is pointed, and the gape wide. The bones of the head and opercular appendages are smooth and lustrous. Those appertaining to the maxillary apparatus are more or less distinctly characterized by fine longitudinal plaits running parallel to the larger diameter of the bones. The surface of the lower jaw is pierced on its under side by seven or more large punctures for the passage of the mucous ducts. Both jaws are furnished with

a single row of smooth thick-set villiform teeth. These are well seen in the enlarged representation of a detached head (fig. 2 of the Plate). The pre-operculum is more uneven superficially than the associated bones, the undulations becoming very strongly marked as they approach the posterior margin, which, however, is not incised. The operculum is triangular, the apex directed downwards; the sub-operculum is nearly as large as the operculum, and both are traversed by indistinct concentric lines of growth. The scales conveying the mucous duct are quadrilateral in the anterior and middle parts of the body, but as they approach the tail the posterior angles are bevelled off, and the long diameter of the scales gradually reduced until they assume the lozenge form. The canal is unusually large, and its course is prominently raised above the surface of the scales. The apertures are for the most part in notches at the posterior margins, but occasionally there is, in addition, an orifice in the centre of the scale. The scales immediately below the lateral line are the largest, and are also quadrangular. Those below this series, as also those above the lateral line, diminish rapidly in size, and lose at the same rate their angular outline. The surfaces of all the scales are perfectly smooth, and invested with a dense covering of ganoiné. The free margins of the larger scales are armed with two or three sharp cusps, but in the smaller scales these are either reduced to a single point or are altogether absent. The fins are mutilated in all the specimens. The pectoral fins appear to have been broad, and to have contained not less than 16 rays. The position of the dorsal fin is rather remote. The ventrals are small, and are placed about the middle of the body; the anal fin is about the dimensions of the dorsal fin, and is situated nearer to the ventrals than to the tail. The latter fin is not preserved in any of the specimens.

Locality.—All the specimens yet discovered of this and the two following species of fossil fish, were found by Mr. Higgins in a single block of Cotham marble from the lower lias of Aust Passage. There are not less than 14 or 15 individuals all grouped together in a matrix not larger than the plate which accompanies this description. Owing to the liberality of the discoverer, specimens of this species are in the collections of the Bristol Institute, the Rev. P. B. Brodie, the Earl of Enniskillen, and my own; and I am indebted to him and the other possessors for the loan of their specimens for the purpose of comparison and description.

PLATE VII. Fig. 6—8.

Pholidophorus nitidus. Sp. Nov.

Description.—Associated with the preceding group of fish, two specimens were found, which although very imperfect, incontestably constitute a new and distinct species of *Pholidophorus*. Among the numerous members of this overcharged genus, many of which are remarkable for graceful forms and proportions, none can vie with the subject of this memoir for symmetry and elegance. As compared with *Pholidophorus Higginsi*, the head is smaller, the body more slender, and the shape and proportions of the scales dissimilar. The imperfection of the specimens precludes a very detailed description of the species, at the same time enough remains to establish specific characters which may be safely relied on. One specimen, belonging to the Bristol Institution, shows the impression of a portion of the head and the opercular apparatus. It was evidently small in relation to the body, and the surface of the bones was smooth and highly polished. The other specimen, of which a representation is given double the natural size, belongs to Mr. Higgins. It shows the greater part of the trunk, together with the dorsal and one ventral fin. These are situated opposite each other, and are composed of a small number of fine fin rays. The scales are beautifully preserved, without either dislocation or fracture, and present the following characters. The principal series, or that constituting the lateral line, contains the largest scales. They are oblong in form, being considerably higher than they are wide. The posterior angles are slightly rounded. The central area of each scale is traversed by a ridge indicating the course of the mucous tube, and in addition to the notch at the posterior margin for the exudation of the lubricating secretion, there is also on each scale a foramen on the upper margin of the tube (Plate 7. fig. 7.) The row of scales immediately below the lateral line is next in importance. In this set the vertical diameter is much reduced, and in the succeeding rows, about four in number, this diminution is progressive, the scales in the vicinity of the ventral fins being nearly equilateral. Above the lateral line one row of large scales occurs, and this is succeeded by four or five rows in which not only are the dimensions exceedingly reduced, but the posterior margins, by the elongation of the lower angles, assume the lozenge form. They are all highly lustrous, and the only irregularities of surface discernable with a pocket lens are the concentric undulations recording the successive growths of the scales.

Locality.—These specimens were found in the same block of Cotham marble at Aust as those described in the preceding memoir.

PLATE VII. Fig. 9—12.

LEGNONOTUS. GEN. NOV.

[Genus LEGNONOTUS (λεγνον, a fringe, νωτος, the back). EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Lepidostei. Sub-family Lepidostei homocerci.) Dorsal fin extending from the nape to the tail; teeth conical.]

Legnonotus Cothamensis. SP. NOV.

Description.—The same block of Cotham marble which contained the two preceding species, yielded also the curious little fish represented in the accompanying plate (fig. 9.), of twice the natural size. The head and detached jaw, of which enlarged views are given at figs. 10. and 11., probably belonged to the same species, at all events they differ entirely from the characters of *Pholidophorus*, the only other genus associated with them. It is not without some hesitation that I have ventured on the slender evidence afforded by a mutilated specimen, and a few fragments to establish a new genus; and I should not have done so, could I by any licence of interpretation of the characters of genera already acknowledged have referred this fish to any one of them. The dorsal fin is a feature of such paramount importance, that it cannot be disregarded; and the peculiarities of this organ in the subject before us, are quite irreconcilable with any genus hitherto discovered. It commences immediately behind the nape and extends nearly to the tail, and contains about 30 rays all supported on strong perpendicular interapophyses. Six or seven of the anterior rays are single spines, rather arched and shorter than the succeeding rays. The latter are thicker than the anterior ones, and although single for some distance from the body, are subdivided at their extremities and traversed by transverse articulations at rather distant intervals. The nearest approach to this construction of the dorsal fin is found in the Sauroid genus *Macrosemius*, but in other respects *Legnonotus* resembles a *Pholidophorus*, or still more nearly the genus *Notagodus*. The former has a small single fin on centre of the back, the latter has a double dorsal fin; features quite sufficient to distinguish them from the subject before us. The fish measures $1\frac{1}{2}$ inch from the insertion of the pectoral fin to the base of the tail, and $\frac{7}{10}$ of an inch in depth. The dorsal fin occupies an inch of the back, and the anal fin is nearly an inch distant from

the pectoral fin. These fins are both small, and the rays continue the greatest part of their length without subdivision; they are, however, fimbriated at their extremities. The scales are very thick and solid, and of variable and rather irregular forms. The ganoid investment is very dense and lustrous. The posterior margins are coarsely serrated. A large fulcral scale occupies the base of the upper lobe of the tail. The latter organ is mutilated, but it is probable from what remains, that it was blunted in form, or at all events not deeply forked. The lateral line is nearly horizontal. The head figured as probably appertaining to this fish shows the operculum and the lower jaw. The former is characterized by a rough pattern of flattened tubercles of enamel, very different in this respect, as also in form, from the corresponding part in the genus *Pholidophorus*. The lower jaw is strong, and armed with a single row of stout incurved teeth, in the form of elongated cones, with rather blunt points, not unlike the outer row of teeth of some of the more slender toothed *Lepidoti* or *Æchmodi*. They are well seen in a detached jaw represented at fig. 11 of the plate. On comparing this figure with the *Pholidophorus* head (fig. 2.), the difference of the dentition of the two genera is easily appreciated.

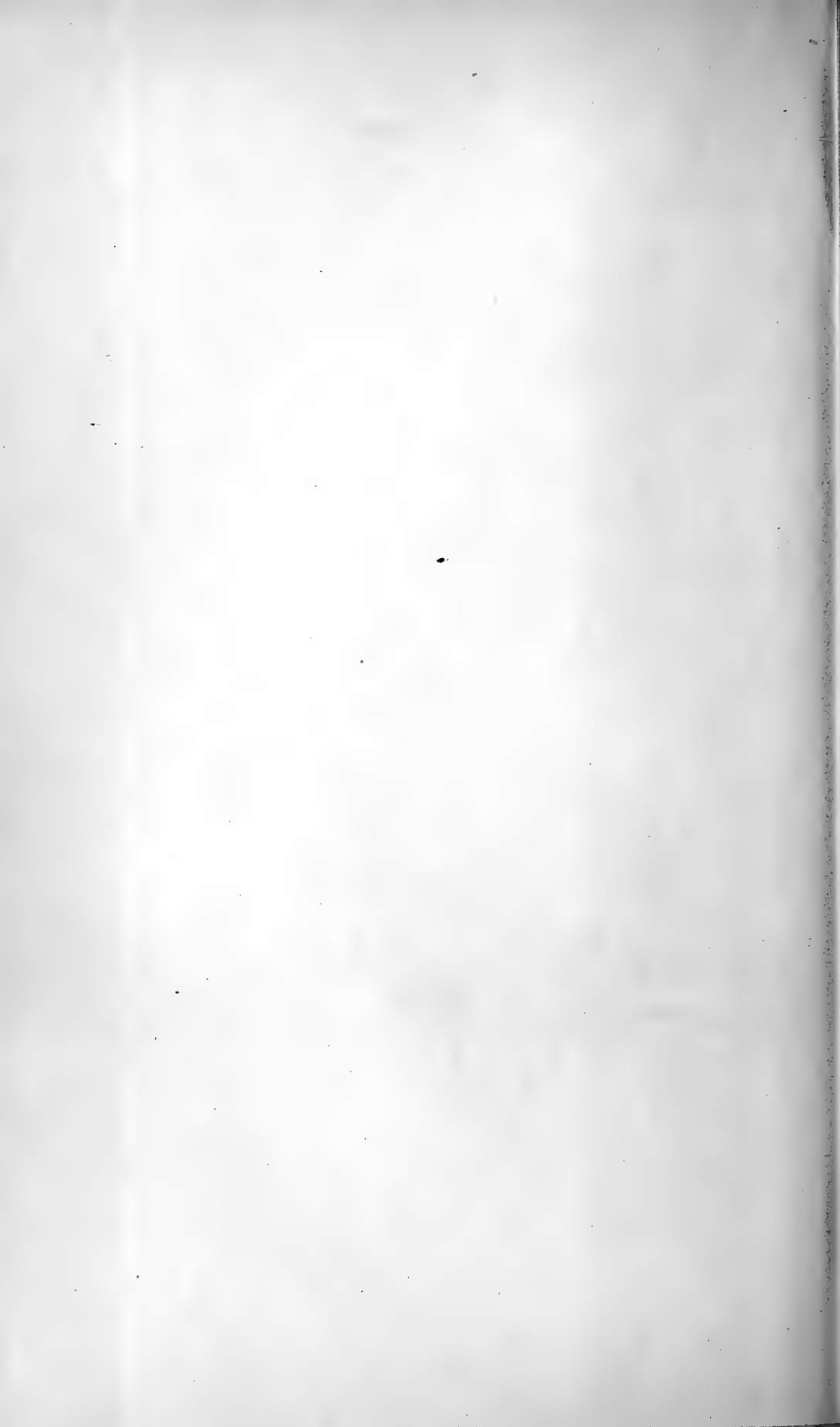
Locality.—This Ichthyolite was discovered by Edmund Thomas Higgins, Esq., at Aust, in the same block of Cotham marble which contained the two species of *Pholidophorus* figured on the same plate. It is in his possession, and I am indebted to his liberality for the opportunity afforded me of making it available for this Decade.

EXPLANATION OF PLATE.

- Fig. 1. *Pholidophorus Higginsi*, size of nature.
 Fig. 2. Head of ditto enlarged, twice the size of nature.
 Figs. 3. 4. 5. Scales of ditto, 4 times the size of nature.
 Fig. 6. *Pholidophorus nitidus*, twice the size of nature.
 Figs. 7. 8. Scales of ditto, 4 times the size of nature.
 Fig. 9. *Legnonotus Cothamensis*, twice the size of nature.
 Fig. 10. Head of ditto ditto ditto.
 Fig. 11. Lower jaw of ditto ditto ditto.
 Fig. 12. Scale of ditto, 4 times the size of nature.

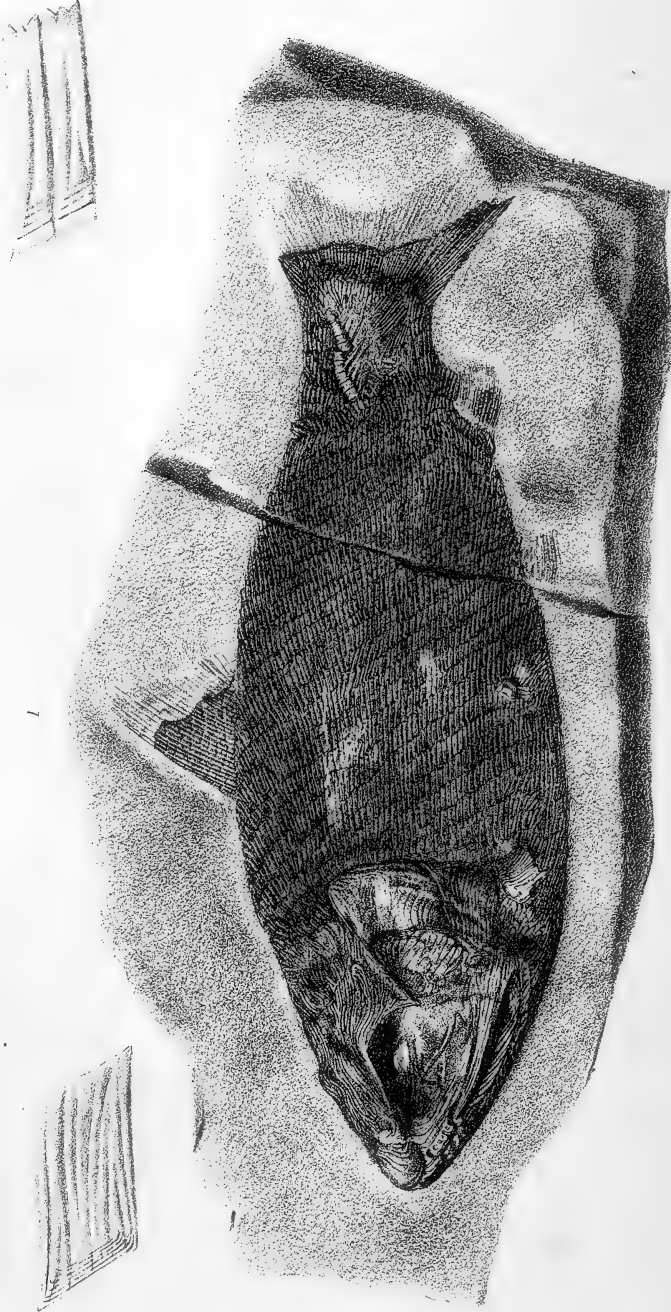
P. DE M. GREY EGERTON.

July 7, 1853.



Geological Survey of the United Kingdom.

DECADE 8. PL. 8.
PTYCHOLEPIS
(Oolitic)



PTYCHOLEPIS CURTUS — Egerton.

W. H. B. D. J. D. J.

See Linkel, l. 116.

PLATE 8. FIG. 8.

BRITISH FOSSILS.

DECADE VIII. PLATE VIII.

PTYCHOLEPIS CURTUS.

[Genus *PTYCHOLEPIS*. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonialepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st Group. Tail forked.) Scales thick, elongated, plicated transversely on the base, and deeply furrowed longitudinally; under-surface smooth, and devoid of rib; pectoral fins pointed; dorsal fin opposite the ventral fins; anal fin remote.]

Ptycholepis curtus, Sp. Nov.

Description.—The beautiful little specimen figured in the plate accompanying this description affords another proof (were further evidence requisite) of the value of dermal characters in the determination of fossil fishes, more especially those of the secondary formations, where the internal skeleton is so rarely preserved. Were a mere outline of the fish before us submitted even to Professor Agassiz himself, I very much doubt whether he would recognize or acknowledge in it a species of his genus *Ptycholepis*, so little do its short and thickened proportions resemble the slim, elegant forms of the Sauroid family in general, or correspond with the known species of its own genus; and yet the inspection of a single scale, or even a fragment of one, would at once reveal to him its true generic affinity. The fish has retained its natural form without distortion of the body or dislocation of its parts. The pectoral, ventral, and a portion of the caudal fin are wanting; with these exceptions, it is in perfect preservation. The length from the nose to the insertion of the tail is $4\frac{3}{4}$ inches, of this measurement the head occupies nearly $1\frac{3}{4}$ inches, more than a third of the entire length. In *Ptycholepis Bollensis*, the head measures only a fourth of the total length. The depth of the body at the dorsal fin is $1\frac{7}{10}$ inches. These proportions serve to distinguish this from the previously known species; they are, however, associated with other distinctive features to be mentioned in the sequel. The head, as noticed above, is large; the outline forms a very regular isosceles triangle. The

orbit is of moderate size, and placed in a forward position. The snout is thickened and rounded at its extremity. The mouth is large, and capable apparently of great distention. The operculum is quadrilateral, and the sub-operculum triangular. The line of junction between them runs obliquely upwards and backwards. The posterior border of these bones is nearly perpendicular. All the cranial bones and their appendages are highly ornamented by deep grooves, arranged in a variety of elegant patterns. On the upper part of the head they are grouped longitudinally, running in sinuous, and sometimes inosculating lines, from the occiput to the snout. On either side the latter, they are retroflexed with a sigmoid curve, exactly resembling the common tattoo pattern on the alæ of a New Zealander's nose. On the premaxillary bone they are parallel to its lower margin, and on the lower jaw they run obliquely downwards and backwards. The opercular bones are less deeply sculptured, and the furrows are more distant. On the posterior angles they become almost obsolete. The scales (with the exception of a few immediately behind the thoracic arch) (Plate viii. fig. 2.) are long and narrow. The base of each is marked by three or four distinct bars. The surface of each scale behind the base is cut by two (or sometimes more) grooves, always varying in length, but rarely extending to the posterior edge of the scale, which is deeply notched. They are all incrustated with a thick and lustrous coat of ganoine. The anterior insertion of the dorsal fin is equidistant from the nose and the commencement of the tail. The fin itself is moderately long, and contains 22 rays. Of these the sixth and seventh from the front seem to be the longest. The transverse articulations of the rays are very frequent near the base, but become more and more distant. After the fourth articulation the rays are grooved, but they do not dichotomise, so far as the fin is preserved in the specimen. It is devoid of fulcral scales. The base of the pectoral fin is all that remains of this organ. The anterior rays are disproportionately strong. The ventral fins are deficient, but they seem from the impression on the shale to have been small. They are inserted below the hinder part of the dorsal fin. The anal fin is small, and very distal in position. Its hinder rays almost reach the tail. The latter is of moderate size, and forked. It has a strong fringe of oblique rays along its upper margin, and a similar one, though finer, protects the lower edge. A few of the terminal vertebræ of the column are preserved. They diminish gradually in size, and terminate at the commencement of the upper lobe of the caudal fin.

Affinities.—The dermal characters of this species associate it very closely with *Ptycholepis Bollensis*; the individual scales, however, are proportionately longer and narrower, and differ in the arrangement of the sculpture. I have evidence of a third species occurring with the two former, in the lias of Lyme Regis, in which the scales are still more elongated; but the subject of the present memoir is easily distinguished from the other members of the genus, by the striking proportions of the fish described above.

Localities.—The only specimen I have seen of this species was found in the lias beds, between Lyme Regis and Charmouth. It is the property of Mr. Beccles, of St. Leonards-on-Sea, to whom I am indebted for permission to figure and describe it.

EXPLANATION OF PLATE.

Fig. 1. *Ptycholepis curtus*, size of nature.

Fig. 2, 3. Scales magnified.

P. DE M. GREY EGERTON.

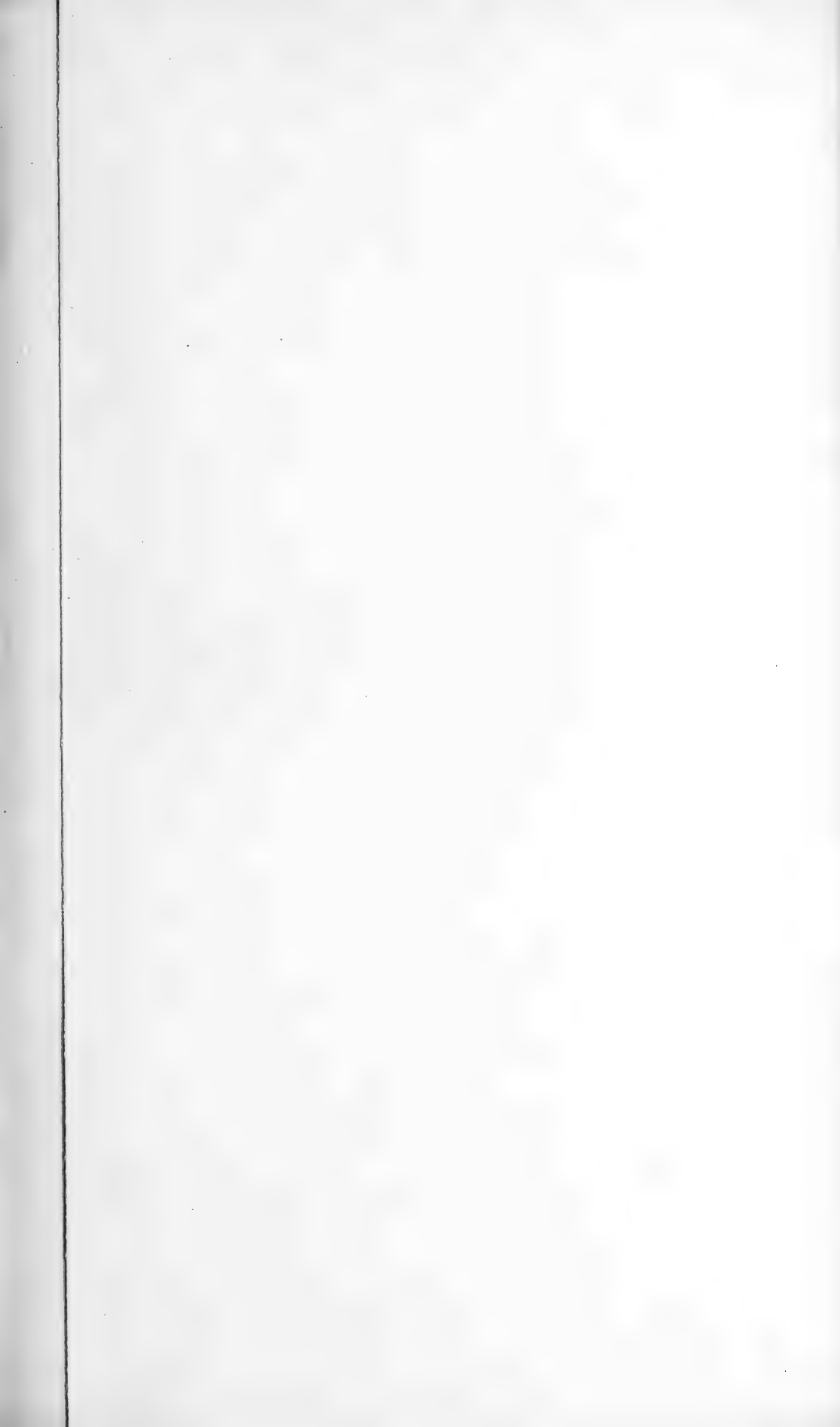
May 1853.

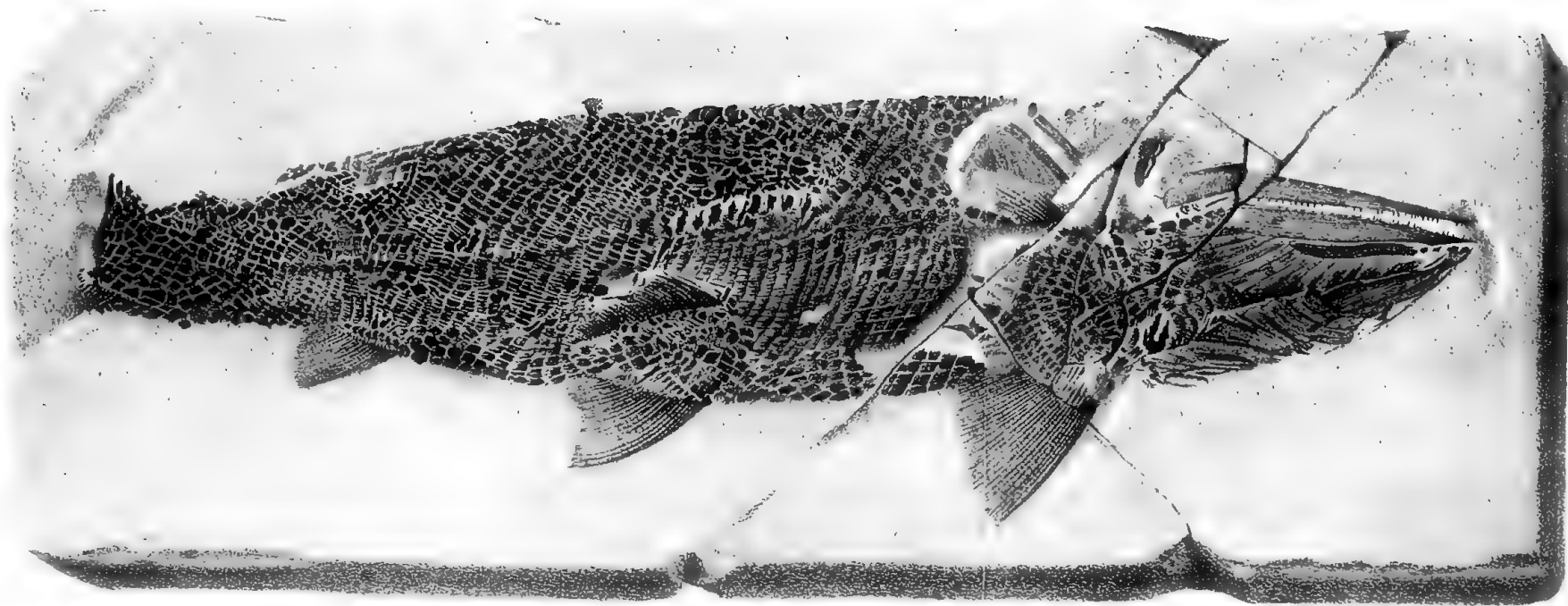
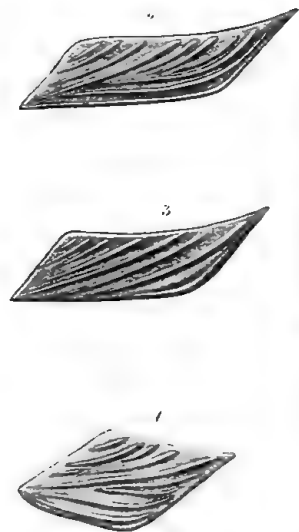
The history of the city of St. Louis is a subject of great interest to the people of the West. The city was founded in 1764 by the French and was one of the most important cities of the continent. It was the seat of the French government in the West and was one of the most important cities of the continent. The city was the seat of the French government in the West and was one of the most important cities of the continent. The city was the seat of the French government in the West and was one of the most important cities of the continent.

HISTORICAL RECORDS

THE HISTORY OF THE CITY OF ST. LOUIS

BY J. H. MOORE





OXYGNATHUS ORNATUS *Egerton*

DECADE 8. PL. 9.

OXYGNATHUS .
(Oolitic)

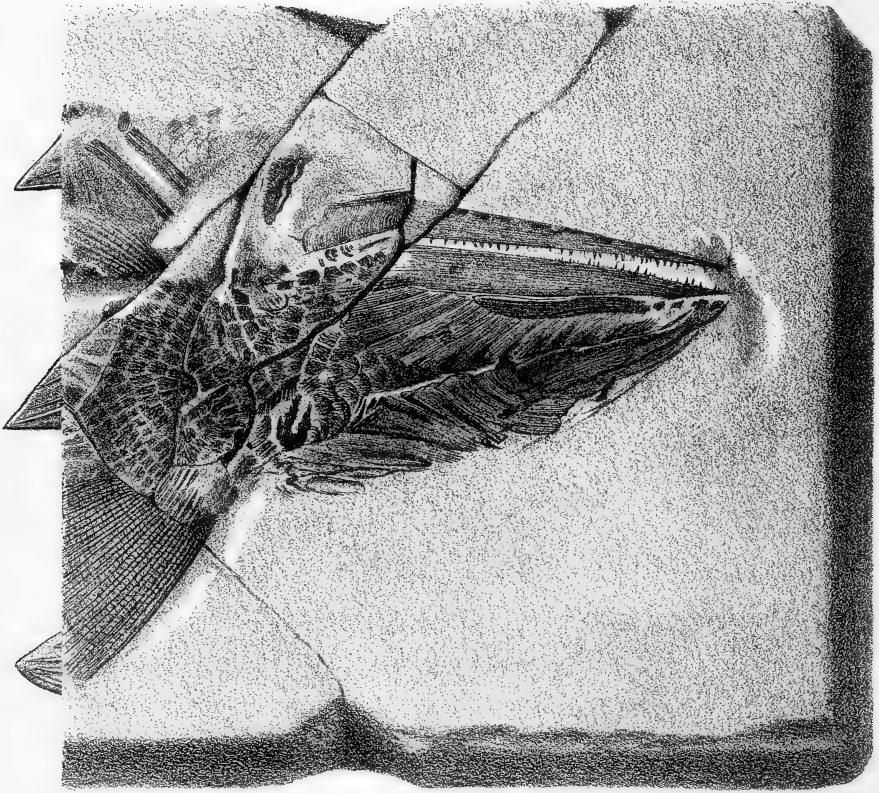
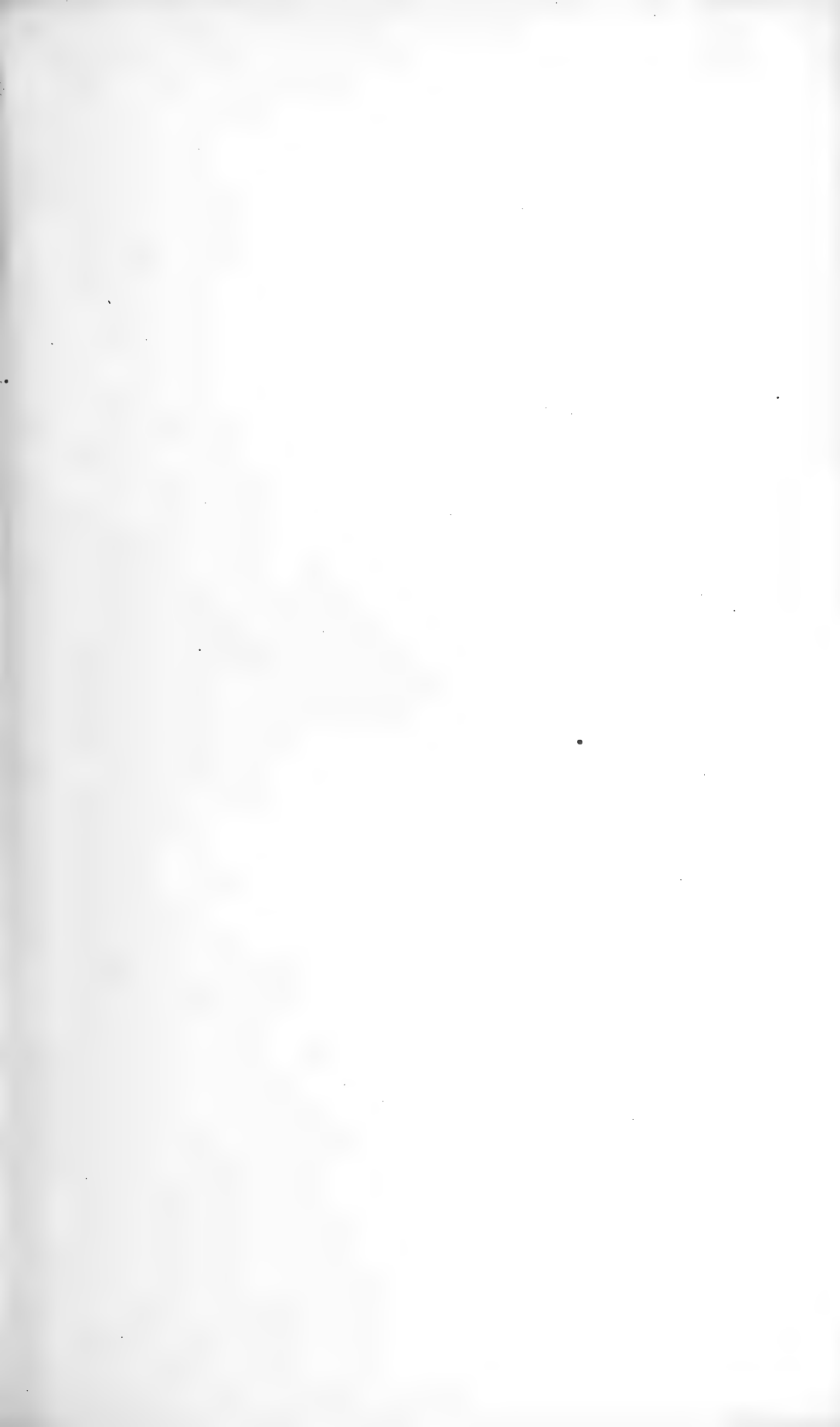
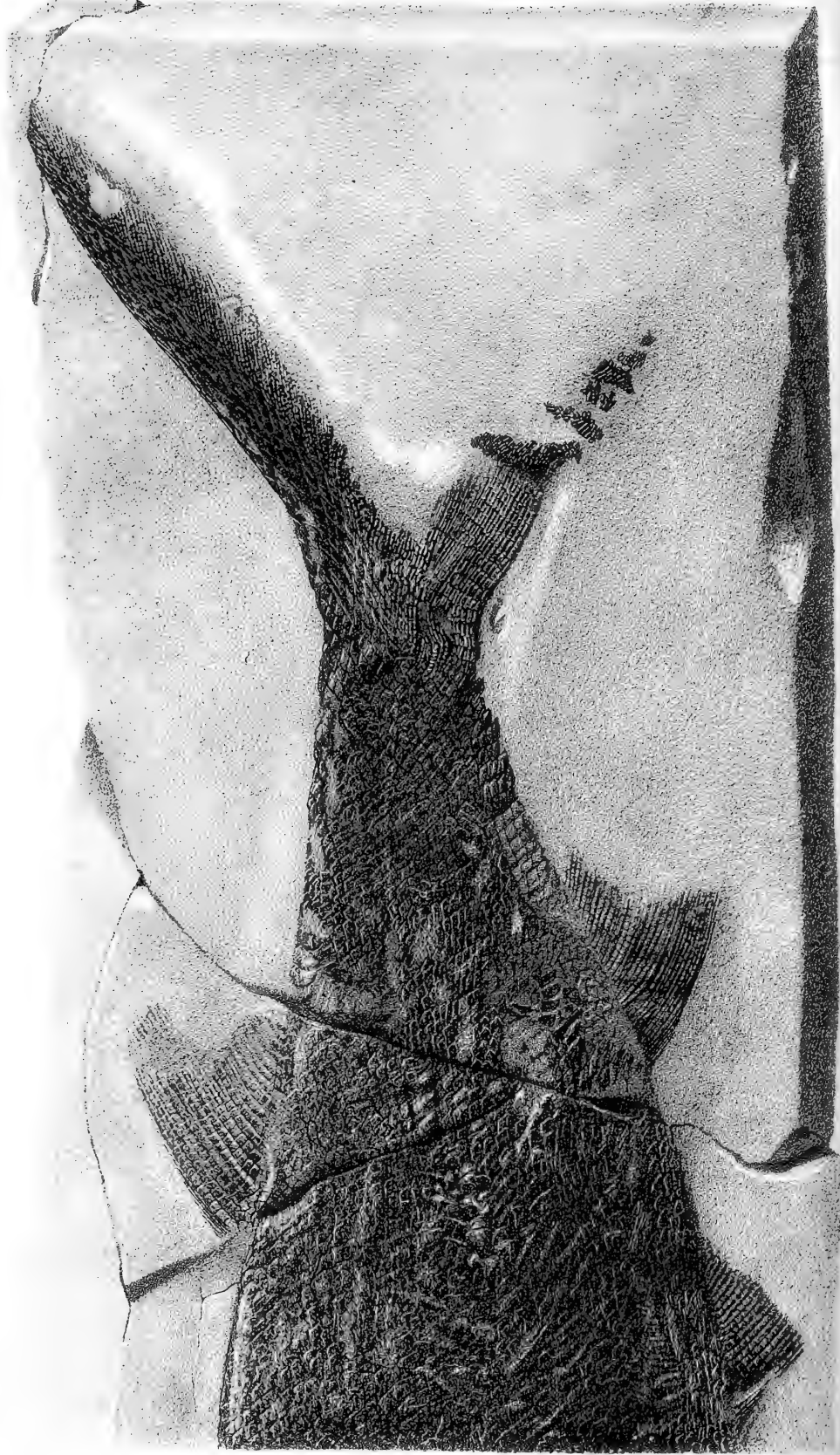


FIG. 1. OXYGNATHUS.





BRITISH FOSSILS.

DECADE VIII. PLATE IX.

OXYGNATHUS. GEN. NOV.

[Genus OXYGNATHUS. EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st Group. Tail forked.) Body elongated; head pointed; jaws furnished with numerous small incurved teeth, intermixed with larger ones; scales thick, small, rhomboidal, and covered with sinuous longitudinal furrows; pectoral fins short and broad; ventral fins large; anal fin small.]

Oxygnathus ornatus, Sp. Nov.

Description.—This fish has so many striking peculiarities, that it has been necessary to create a new generic title for its designation. The slender lanceolate form of the body resembles some species of *Eugnathus*, the characters of the teeth and jaws approach those of *Sauropsis*, while the peculiar ornamentation of the scales can only be compared to that found in the heterocerque genus, *Acrolepis*. The combination of these characters, and the addition of others not found in the above cited genera, establish the propriety of selecting for this form a new generic appellation. The specimen measures $9\frac{1}{2}$ inches, from the snout to the base of the caudal fin, of which the head occupies 3 inches. The greatest depth of the body was probably not more than 2 inches, but the attitude of the fish is such that this measurement cannot be ascertained with precision. This, however, is clear, that the deepest part was immediately behind the nape, from which point the body gradually tapers to the tail. The dorsal and caudal fins are both absent. The form of the head is more pointed than in any of the Sauroid genera, except those with elongated muzzles, such as *Aspidorhynchus*, *Belonostomus*, and *Saurichthys*. In consequence of the extreme tenuity of the bones of the head few are preserved entire, with the exception of the dentigerous bones, and the hyoid and branchiostegous apparatus. These are all covered with a surface ornament, composed of fine vermicular plaits of enamel, arranged for the most part in longitudinal direc-

tions. The remnant of one of the opercular bones shows that this pattern did not extend to those bones; they seem, however, to have been covered with a fine and rather indistinct granulation, intermixed with raised lines, running parallel to the posterior margin of the flap. The teeth are numerous in both jaws. The larger ones are conical, sharp, and hooked at the extremity. The smaller ones are of the same form, and fill up the irregular interspaces between the larger ones. They together form a single row, fringing the margins of the mouth. The symphysis of the lower jaw is remarkably acute. The branchiostegous rays are beautifully displayed, occupying the angle between the jaws. There appear to have been about twelve on either side. The pectoral fins are composed of a series of flattened rays, about thirty in number. They are devoid of transverse articulations, but dichotomise when near their extremities. The ventral fins are situated nearer to the anal than to the pectoral fins. They are smaller than the latter, although larger than the corresponding organs in the allied genera. They contain, in addition to three or four small marginal appendages, about 24 rays. These are rounded, have frequent transverse articulations, and bifurcate at their extremities. The anal fin is short and small. It occupies a position midway between the anterior insertion of the ventral fins, and the commencement of the tail. It contains 16 or 18 rays of similar character to those composing the ventral fins. The scales are small, and very numerous. They vary in form and size, on different parts of the body, but they all correspond in the character and distinctness of the surface ornament. This consists of elevated ridges of enamel, arranged for the most part in longitudinal directions, in reference to the outline of the fish; but obliquely as regards the individual scales. On the nape a few granulations are interspersed with the ridges. The latter, however, predominate in all other regions of the body. The scales near the tail are thicker than those on other portions of the trunk, and the ornament more coarse. Each scale has a thick rib on its under surface, which locks in reciprocally with that of the adjoining scale, and secures the continuity of the series against accidental dislocation.

Affinities.—The character of the scales alluded to above marks out the genus *Oxygnathus*, as distinct from all others. The only approach to it is in the genus *Acrolepis*, but (in addition to the latter being a heterocerque fish, which alone would forbid the union,) the differences in the form of the scales, and the arrangement of the sculpture, sufficiently distinguish it from that genus. A slight re-

semblance may, perhaps, be traced between these scales and those of *Gyrolepis*; but, here again, we have probably a heterocerque fish, it being restricted to beds older than the lias. As compared with the Liassic Sauroid genera, already described, this fish differs from them all, nor can it be ascribed to any of those genera named, but not yet described, viz., *Thrissonotus*, *Centrolepis*, *Endactis*, or *Cosmolepis*.

Locality.—The figure and description are taken from a specimen in the collection of the Earl of Enniskillen, found in the lias at Lyme Regis.

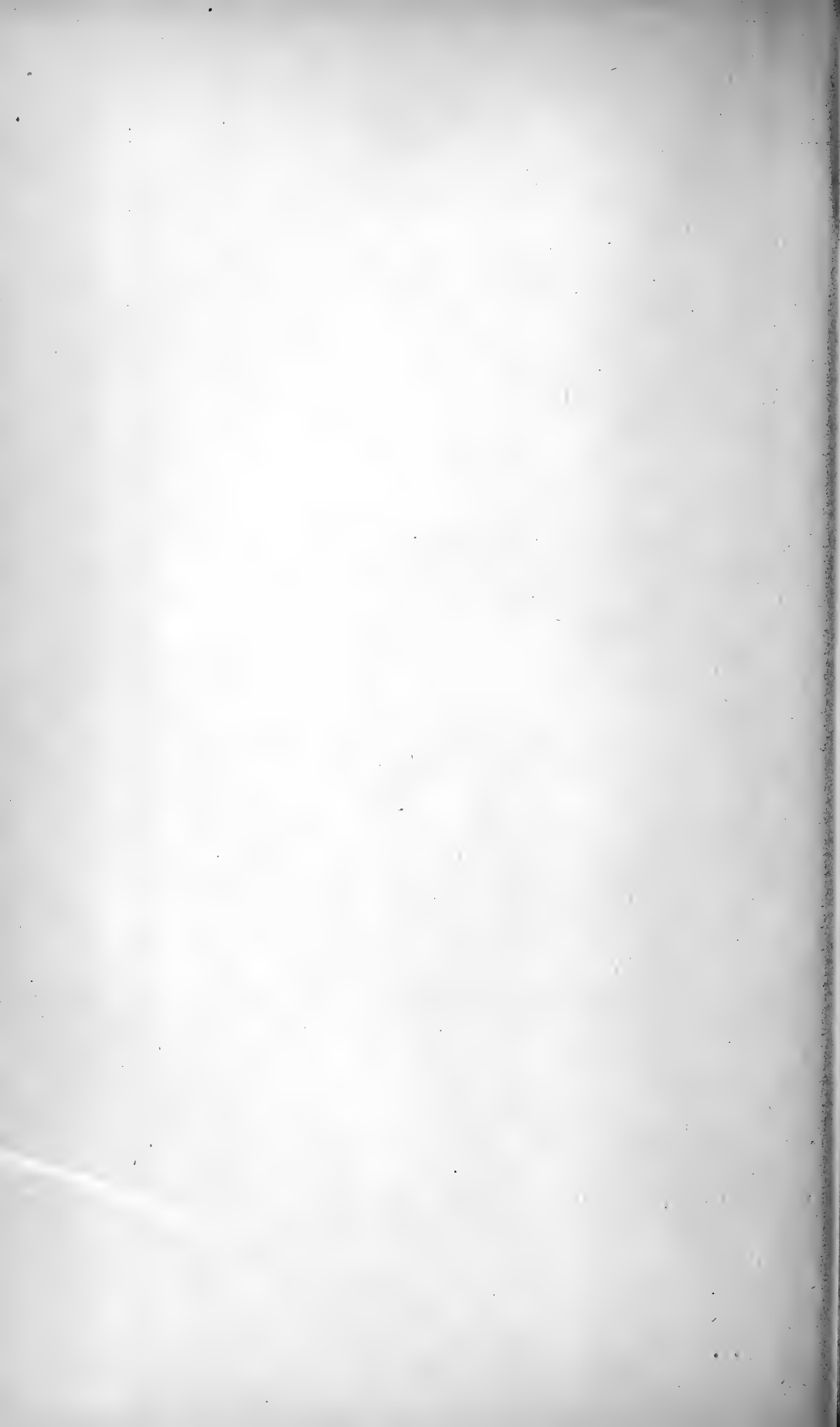
EXPLANATION OF PLATE.

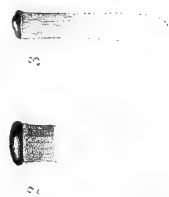
Fig. 1. *Oxygnathus ornatus*, size of nature.

Fig. 2, 3, 4. Scales of ditto, magnified.

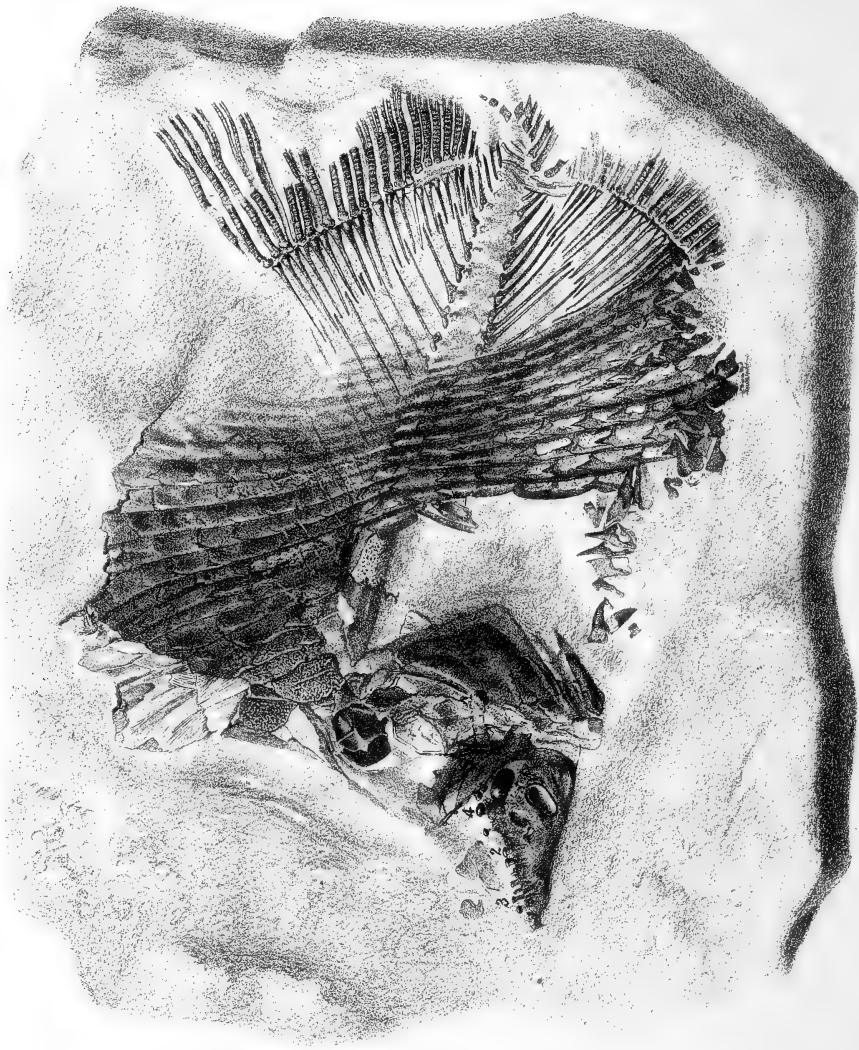
P. DE M. GREY EGERTON.

May 1853.





6



Jos Dmizel, lith.

PYCNODUS LIASSICUS — *Egerton*.

H. Forbes, direct.

Plate Geol. Surv. U.K., vol. 3.

BRITISH FOSSILS.

DECADE VIII. PLATE X.

PYCNODUS LIASSICUS.

[Genus PYCNODUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Pycnodontidæ.) Body short, deep, and adpressed; three or five rows of smooth, flattened, oblong, tritoral teeth, on each ramus of the lower jaw; five rows of similar teeth on the vomer; incisive teeth in both jaws.]

Pycnodus liassicus, Sp. Nov.

Description.—The announcement of the occurrence of fishes belonging to the family *Pycnodontidæ*, in the lias of Great Britain and Wurtemberg, recently made in a memoir read at the Geological Society,* has been quickly followed up by the discovery of a true *Pycnodus*, from the same formation. This interesting specimen was brought to light during the operation of transferring the fine collection of fossil fishes in the British Museum, from the cases in Room 6, to their new position in Room 2. It is supposed to have been derived from the lias of Barrow-on-Soar, and, although far from perfect, is, nevertheless, sufficiently so to leave no doubt as to its natural affinities. In referring it to the genus *Pycnodus*, I have been guided mainly by the characters of the dentary apparatus. The general contour of the body has more resemblance to a *Microdon*, or a *Gyrodus*, and wants the elongated caudal pedicle of the typical *Pycnodi*; but the characters of the teeth are so decisive, that I have no hesitation in referring it to the latter genus. The specimen figured in the plate measures from the symphysis of the lower jaw to the commencement of the tail, 4 inches. The greatest depth, following the direction of the dorso-ventral series of scales, is $3\frac{1}{2}$ inches. The anterior portion of the trunk is highly vaulted; the summit of the nape being nearly 1 inch higher than the occiput. The frontal and facial line is straight, and steeply inclined. The lower jaw is unusually large (fully 1 inch in length), and renders

* Quarterly Journal of Geol. Soc., 1853, page 276.

the prognathic character very decided. The orbit is situated in a high and very forward position. The upper limb of the operculum is nearly horizontal; the posterior margin slopes downwards and forwards, in an easy curve. The preoperculum is high and narrow. Wherever the surface of the cranial bones is preserved, it is covered with small flattened granules, distinct from each other, and not grouped in radiating or other patterns. The anterior or incisive teeth are elongated cones, slightly flattened at the apices; the succeeding teeth are shorter and broader. The outer row only is visible, and these being comparatively small, we may conclude from the general rule applicable to this genus, that each ramus had five rows of teeth, those comprised in the second row being considerably larger than the remainder. One large tritor is seen in a position which indicates that it belonged to the central or principal row of the vomerine teeth. Several smaller ones scattered about may have belonged to the lateral series, of which there were probably two on either side of the central one. The form of all these teeth is more or less oblong, and the crowns are smooth, devoid alike of the inequalities of the *Microdon* teeth, and the rugosities of the *Gyrodont*. The dorsal and anal fins are large, and opposed to each other. The former has 20 rays, the latter about 15. These are all articulated to dilated extremities of strong interapophyseal osselets. The rays are single at first, but they soon dichotomize, and are marked by very closely arranged transverse articulations. The course of the spinal column is nearly straight, and does not coincide with the arched form of the dorsal outline. The vertebral centra were cartilaginous, but the apophyses strong and bony. The scales are much mutilated. Those of the nuchal region are the largest. The impression left on the stone proves them to have been ornamented with diverging curved lines of small tubercles, sweeping downwards and outwards from the central area of each scale. The succeeding scales below are of smaller dimensions, but they all partake of the high narrow character so generally prevailing in this family. They are covered with small flattened tubercles, similar to those found on the bones of the head. No evidence remains of the form or position of the pectoral or ventral fins. It has been stated above that the form of this fish differs from that recognized as typical of the genus *Pycnodus*, but this remark must be taken as having reference to the state of our knowledge of the genus. Agassiz founded its generic attributes on the well-known *Pycnodus platessus*, of the Monte Bolca beds, and in this tertiary form the elongation of the pedicle of the tail is very striking. The only

other species of which the trunk is preserved, with the exception of the species of *Pycnodus orbicularis*, in the Paris Museum, is the small *Pycnodus rhombus*, found in the Jura (?) beds of Torre d'Orlando, near Castel-à-Mare; and in this older form this peculiar character is less prominent. The remaining thirty-two species enumerated and partly described in the "Poissons Fossiles," ranging from the tertiary formation down to the Keuper, are only known by their teeth. It is, therefore, quite possible that the Oolitic species may have resembled the other *Pycnodonti* of that period, in the more rounded outline of the body, and that this must therefore be considered a specific rather than a generic condition. Be this as it may, the characters derived from the dentition are of so much greater moment than the mere outward form of the fish, and they coincide so entirely with those of the well-known dental apparatus of the genus *Pycnodus*, that no doubt remains upon my mind as to the propriety of assigning the subject of this article to that genus.

Locality.—The only specimen I have met with of this species is the one represented in the plate.

EXPLANATION OF PLATE X.

- No. 1. *Pycnodus liassicus*, size of nature.
Nos. 2, 3. Front teeth, magnified.
Nos. 4, 5. Vomerine tritor, ditto.
No. 6. Nuchal scale, ditto.

P. DE. M. GREY EGERTON.

July 7, 1853.

The Board of Directors has the honor to acknowledge the receipt of your letter of the 15th inst. in relation to the matter mentioned therein.

REPORT OF THE BOARD OF DIRECTORS

1901

The Board of Directors has the honor to acknowledge the receipt of your letter of the 15th inst. in relation to the matter mentioned therein. The Board has considered the same and has decided to grant your request.

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SUPPLEMENT TO DECADE VIII.

THE delay which has occurred in the publication of this Decade has been so far fortunate, that in the interval which has elapsed since the completion of the manuscript, several specimens have been discovered, of species described therein, substantiating the characters already given, and supplying others which were deficient in the materials originally examined. As several of the species were founded upon single specimens, it is of consequence that the opportunity of recording this additional evidence should not be lost, although it would not be advisable to incorporate it in the descriptions completed two years since, and which are now in type.

ARTICLE V. PLATE V.

Histonotus angularis.—This genus and species was determined by a single specimen, in my own collection. The Museum of Practical Geology has now two specimens of the genus, one of which belongs, no doubt, to the same species. The other is a portion of a much larger fish, and may possibly indicate a second species, but it is too imperfect to afford any reliable evidence of distinctive character. Both these specimens are from the Swanage quarries.

ARTICLE VI. PLATE VI.

Aspidorhynchus Fisheri.—The British Museum and the Museum of Practical Geology now possess good specimens of this species. The original of Plate 6 is so perfect, that no further evidence was necessary to complete the specific description.

ARTICLE X. PLATE VIII.

Ptycholepis curtus.—This species depended on the evidence of a single specimen, in the possession of Mr. Beccles. A second specimen has recently been sent to me from Lyme Regis (whence the first was also derived), showing some details which were wanting in the one originally described. The pectoral fins are here preserved. They are composed of from 18 to 20 rays each. These are strong, and closely arranged. They are single as far as they are preserved, and show no transverse articulations. The anterior margins of these fins were bordered. The ventral fins are placed nearer to the pectoral than to the anal fins. They are small, and composed of 10 or 12 slender articulated rays; the articulations only commencing near the extremities. The caudal fin contains about 20 rays in the upper, and 30 in the lower lobe. The former is strengthened by a ridge of elon-

gated scales, overlapping its base. Five or six of the upper fin rays are much stronger than the succeeding ones, and have no transverse articulations until near their extremities; the remaining rays of the upper lobe, and all those composing the lower lobe, have very frequent articulations from the base to the extremity. The length of this specimen is $5\frac{1}{2}$ inches from the nose to the commencement of the caudal fin; the depth from the nape, $1\frac{3}{4}$ inches. The length of the head from the nose to the posterior edge of the operculum, 2 inches.

ARTICLE XI. PLATE IX. AND IX*.

Oxygnathus ornatus.—The fortunate discovery of a most perfect example of this rare fish enables me to complete the description of those parts that are either mutilated or wanting in the specimen originally examined. The recent acquisition measures 11 inches from the snout to the fork of the tail, and 3 inches in depth between the nape and the dorsal fin. The position of the fish is such that all the fins of the left side are shown, and by a lucky upturning of the lower jaw, both rami, together with the hyoid and branchiostegous apparatus are displayed. The parts shown in this specimen, which were deficient in the former one, are the dorsal and caudal fins. The more perfect condition of the anal fin renders some correction requisite in the description formerly given of this organ. It is, in fact, not so small as I was led to suppose, but is in full proportion to the other locomotive organs. It commences anteriorly with a few graduated jointed rays, and not with the single fulcral rays frequently found in this position; these are succeeded by the principal rays, about 30 in number, which decrease in length rapidly as they recede towards the tail. The transverse articulations of the principal rays are frequent near the base of the fin, but occur at greater intervals on the more distant portion; on the posterior rays they are also frequent, but uniform throughout. The dorsal fin is situated immediately above the interspace between the ventral and anal fins. It was furnished, like the anal fin, with a few soft slender rays on the anterior margin. The succeeding rays correspond also in size and character with those of the anal fin. In consequence of a slight mutilation of the hinder extremity of the fin, the exact number of the rays cannot be ascertained; it was certainly not less than 30. The most remarkable and wholly unexpected character of this fish is presented by the form and structure of the caudal fin. This organ is deeply cleft into two lobes; the upper one measures $3\frac{1}{2}$ inches in length, the lower one only $2\frac{1}{2}$. The former has a scaly investment from the base to the extremity, below which issues a fringe of innumerable fine rays, with frequent transverse articulations and longitudinal bifurcations. The lower lobe contains about 24 rays; of these the strongest occupy the middle of the lobe, those of the upper and lower margins becoming gradually finer as they recede from the centre. The transverse joints are nearly equidistant, but the intervals are greater than those on the dorsal and anal fins. It results from these peculiarities that this fin in *Oxygnathus* not

only simulates the tail of a true heterocerque fish, but carries the resemblance to an extent only found in the most heterocerque genera. I question whether any one on seeing a drawing of this fin would hesitate a moment in pronouncing it a palæozoic form. The solution of this problem depends upon a single point, viz., whether the rays constituting the upper lobe of the tail are all short rays, given off from the lower elements of the vertebral column, or whether any of them are continued under the scaly integument to the upper part of the column. The evidence the specimen affords is this: the centrum in the vertebræ of this genus was ossified, a fact proved by the occurrence of several of these bodies, seen in the specimen, where the integuments have been removed. Being thus qualified to resist decomposition, while the softer parts perished, the course of the spinal column becomes evident by a slight elevation of the surface where the scaly integument rests upon it. In tracing its direction in the posterior part of this fish, it exhibits no tendency to mount into the upper lobe of the tail, as in the typical heterocerque fish, and, to a certain extent, in *Ophiopsis*, *Eugnathus*, and some other homocerque forms; but, on the contrary, it seems to terminate abruptly at the base of the tail. For this reason I am inclined to think that, without more conclusive evidence, it would be unwise to consider this an exception to the general rule, with reference to the fish of the lias, although the actual resemblance of this tail to that of a heterocerque is so striking as almost to warrant a contrary conclusion.

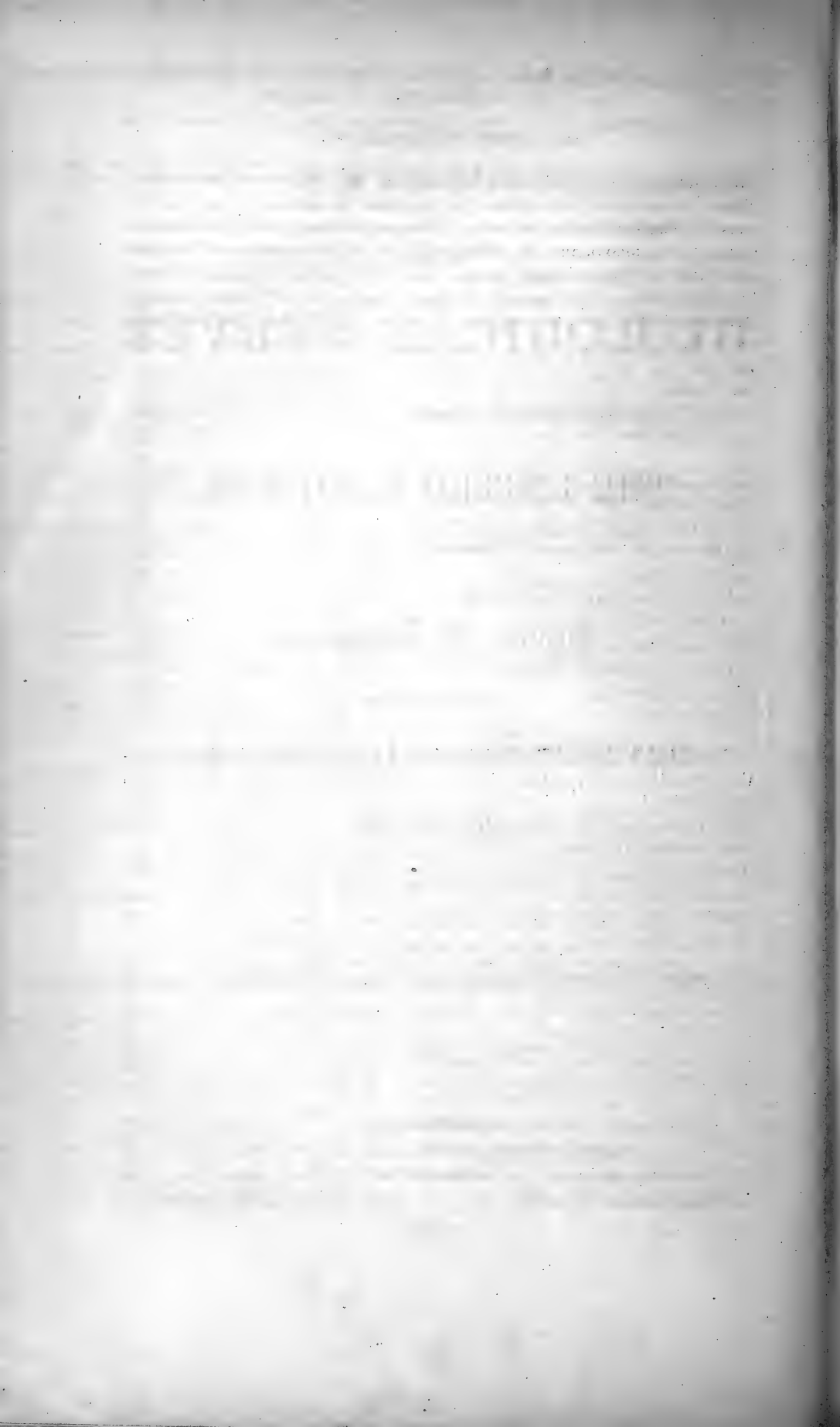
ARTICLE XII. PLATE X.

Pycnodus liassicus.—The opinion I ventured to express in the description of this specimen, that the more shortened contour of the body as compared with the typical *Pycnodus platessus* ought not to exclude it from that genus, has been fully confirmed by the discovery of several new species of *Pycnodus* in the colitic slates of the Bugey. Monsieur Thiolliere, in one of the most splendid works ever contributed to palæontological literature,* has described and figured, together with other new and interesting forms, five species of this genus. Of these two are more elongated than *Pycnodus platessus*, and of the three shorter species two, viz., *Pycnodus Egertoni* and *Pycnodus Bernardi*, correspond in form with liassic species described in this Decade. There seems to be some doubt as to the locality from which the British Museum example of this fish was derived. In the course of last autumn I saw a second specimen of this species presented to the Worcester Museum by the Rev. W. Symonds, which was found in the lias of the neighbourhood of Tewkesbury.

P. DE M. GREY EGERTON.

April 16, 1855.

* Descriptions des Poissons Fossiles provenant des Gisements corallines du Jura, dans le Bugey.



MEMOIRS
OF THE
GEOLOGICAL SURVEY
OF
THE UNITED KINGDOM.

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*Figures and Descriptions*

ILLUSTRATIVE OF  
BRITISH ORGANIC REMAINS.

—  
DECADE IX.

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PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

LONDON:
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1858.

PREFACE.

IN issuing this Decade to the Public, justice requires that I should express the great obligations of this Establishment to Sir Philip de Malpas Grey Egerton, who had previously undertaken and completed two similar works at the request of my predecessor, Sir Henry T. De la Beche.

The present Decade contains descriptions and figures of six new genera of Fossil Fishes, three of which had been named by Agassiz, but not described or figured.

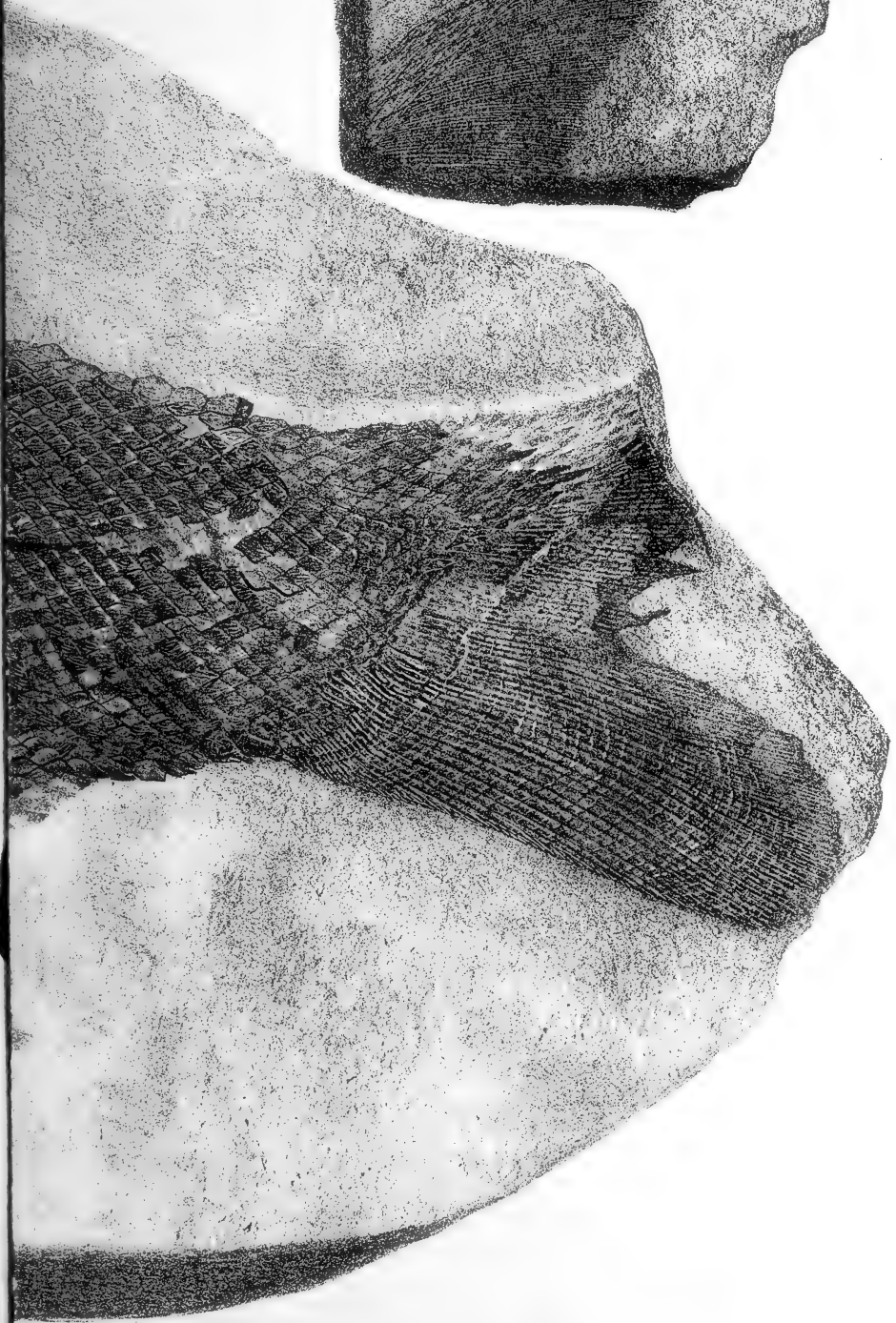
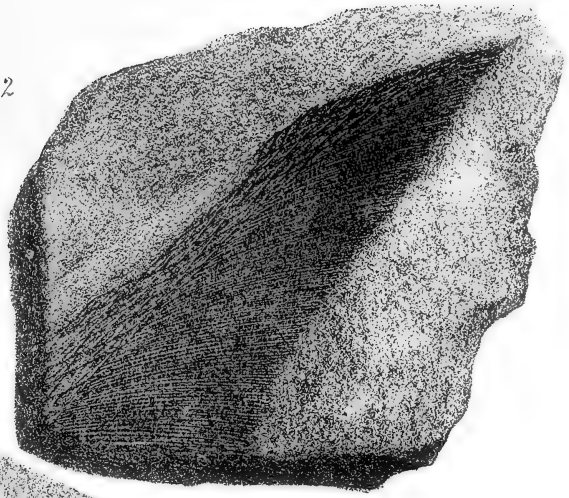
In these three Decades of Fossil Ichthyolites, Sir Philip Egerton has described nine new genera and thirty-five species; and in calling attention to his valuable labours, I beg especially to notice the very skilful execution of the Plates by Mr. Dinkel, whose truthful delineations of detail, combined with artistic effect, cannot be surpassed in this branch of Palæontology.

RODERICK I. MURCHISON,
Director.

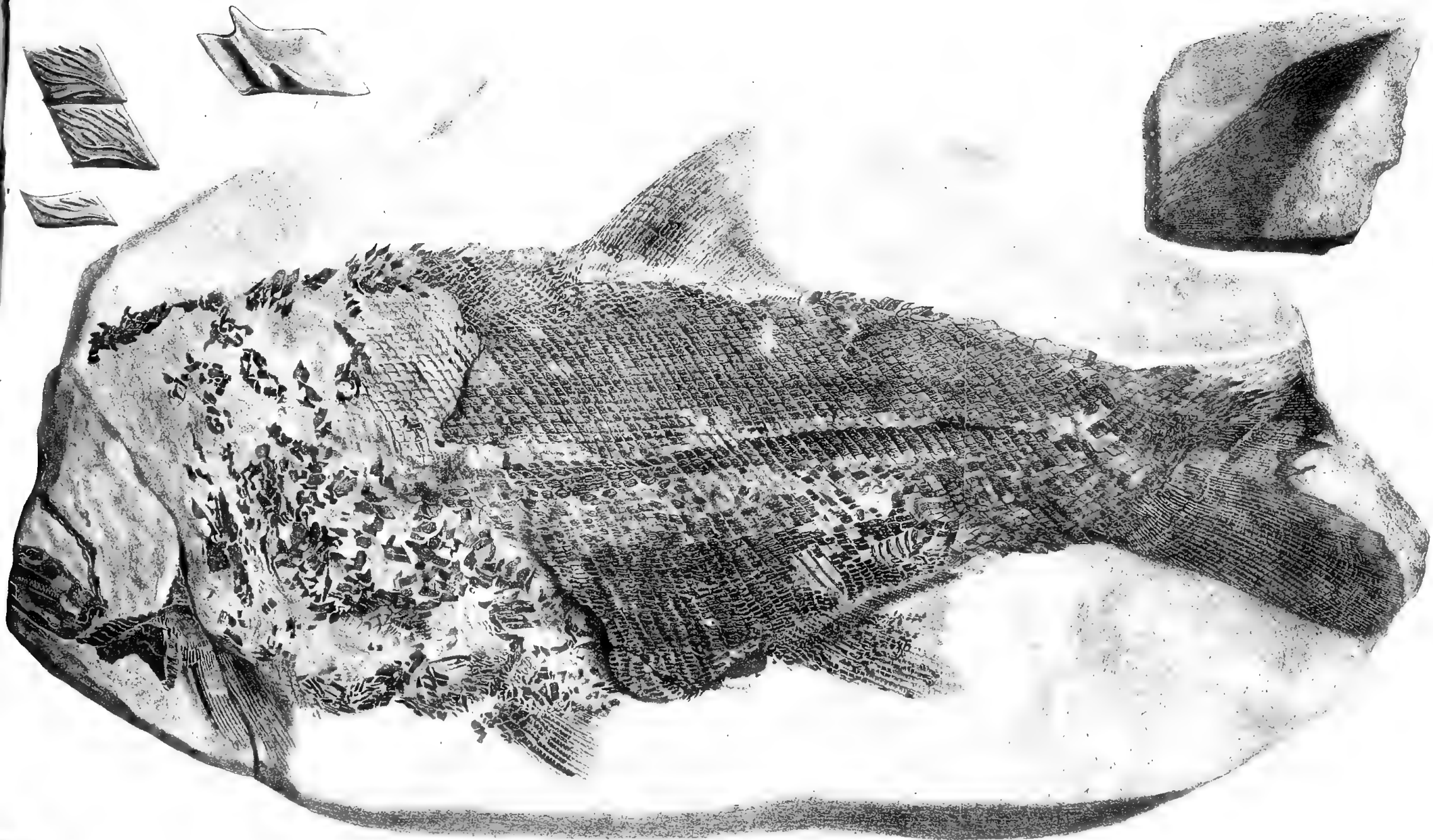
Museum of Practical Geology,
16th November 1857.

THE UNIVERSITY OF CHICAGO

2









BRITISH FOSSILS.

DECADE IX. PLATE I.

COSMOLEPIS. GEN. NOV.

[Genus COSMOLEPIS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st group, tail forked.) Body oval. Head small. Scales thick, small, numerous, and rhomboidal; sculptured on their surfaces. Pectoral fins large; ventral fins near the pectorals; dorsal fin in advance of the median line, over the interspace between the ventral and anal fins; anal fin extended; caudal fin large, springing from a broad pedicle.]

SPECIES UNICA. *Cosmolepis Egertoni*. AGASSIZ, MS. *Morris, Cat. Brit. Foss.*, 1854.

In the generic characters here given, I have endeavoured to express those features which distinguish *Cosmolepis* from the several sauroid genera with which it has affinities in other respects. The form of the trunk corresponds with that of *Pachycormus*, the advanced position of the dorsal fin with *Caturus*, the extent of the anal fin with *Sauropsis*, and the character of the scales and caudal fin with *Oxygnathus*. It differs from *Pachycormus* and *Caturus* in having thick sculptured scales, in the form of the tail and in the proportions of the anal fin; from the former in the position of the dorsal fin. It differs from *Sauropsis* and *Oxygnathus* in the greater depth of the trunk in relation to its length, and in the arrangement of the locomotive organs; and from all in the forward position of the ventral fins. The genus was established by Professor Agassiz, immediately before his departure for America, from the examination of a single specimen belonging to Lord Enniskillen, and found in the lias quarries at Barrow-on-Soar. A second specimen has been found since (now in my possession), which agrees in generic and specific details with the original.

Description.—The anterior half of the head is deficient in both specimens; in other respects they are in a good state of preservation. The type specimen is selected for the general description, as being the most perfect, but some of the details are derived from the last found specimen. The form of the body is elliptic, the dorsal and

ventral lines forming graceful and symmetrical curves. The pedicle of the tail is slightly prolonged and gradually contracted, but not to so great an extent as in *Pachycormus*. The length of the body from the nape to the base of the upper caudal lobe measures one foot; the greatest depth in front of the dorsal fin is four inches and three quarters; the pedicle of the tail two inches; from the nape to the dorsal fin is five inches, and thence to the tail seven inches. From the pectoral to the ventral fins is three inches and a quarter; from thence to the anal fin, three inches and a half, and thence to the lower caudal lobe four inches. The pectoral fin is composed of about twenty-five rays, the first of which is much stronger than those behind it. The ventral fins are much dislocated; the number of the constituent rays cannot therefore be ascertained. They appear to have been broad, and the rays were thick, flattened, and frequently subdivided transversely. The dorsal fin had a few slight fulcral scales at its base, but neither in this or the other fins is there any evidence of the first ray having a fringed margin. It contained not less than fifty rays, closely arranged, flattened, and composed of very numerous ossicles. The longest, forming the apex of the fin, measure two inches and a quarter in length; from the apex to the hinder margin of the fin the rays decrease rapidly in length, forming with the base line and anterior outline of the fin a nearly equilateral triangle. The rays of the anal fin are too numerous and indistinct to be accurately numbered. They correspond in character with the dorsal rays, but are shorter, and decrease in length more gradually towards the tail. The base of the fin measures two inches and three quarters, and it may be computed to have contained at least seventy rays. The caudal fin is broader and not so deeply cleft as that of *Oxygnathus*, but it corresponds with it in having the upper lobe invested with scales. So strongly marked is this character in both genera, that the doubts I have already expressed in the description of *Oxygnathus* as to the propriety of considering that a homocerque form, are much strengthened by the examination of *Cosmolepis*. The rays composing the caudal fin of *Cosmolepis* are far more numerous and frequently jointed than those of the corresponding organ of *Oxygnathus*. Those of the upper lobe decrease in length and substance as they approach the extremity, and are supported by the prolonged upper limb of the organ, features quite at variance with homocercal structure. There is no evidence in this genus of the prolongation of the vertebral column into the upper limb of the tail; on the contrary, there are symptoms of the abrupt termination of the ossified vertebræ at the fork; it

may be, however, that the embryonic character was persistent in the hinder extremity of the column, notwithstanding the ultimate development of its other parts. The scales of this fish are remarkable for their great number and the beauty of their sculpture. The dorso-ventral rows on the flanks contain nearly sixty scales in each. Those on the flanks in the vicinity of the line of the vertebral column (which was nearly straight and equidistant from the back and belly) are larger than the dorsal and ventral scales; but on the after part of the body they are all of uniform size. The under surface of each scale has a strong process on the upper margin, which corresponds with a pit on the lower margin of the scale above it; in addition to this, these margins are bevelled, so that additional strength is secured by the overlap of the juxtaposed scales in the dorso-ventral series. The external surface of each scale is ornamented with five or six raised lines of enamel, some single, some bifurcate. These are most frequent on the scales of the anterior parts of the fish, but they are distinctly developed upon all. These dermal characters agree closely with those of *Oxygnathus*. The small portions of the jaws which remain show the bases of strong sauroid teeth; the other parts of the head are deficient.

Locality.—Lias of Barrow-on-Soar, Leicestershire.

EXPLANATION OF PLATE.

Fig. 1. *Cosmolepis Egertoni*, size of nature.

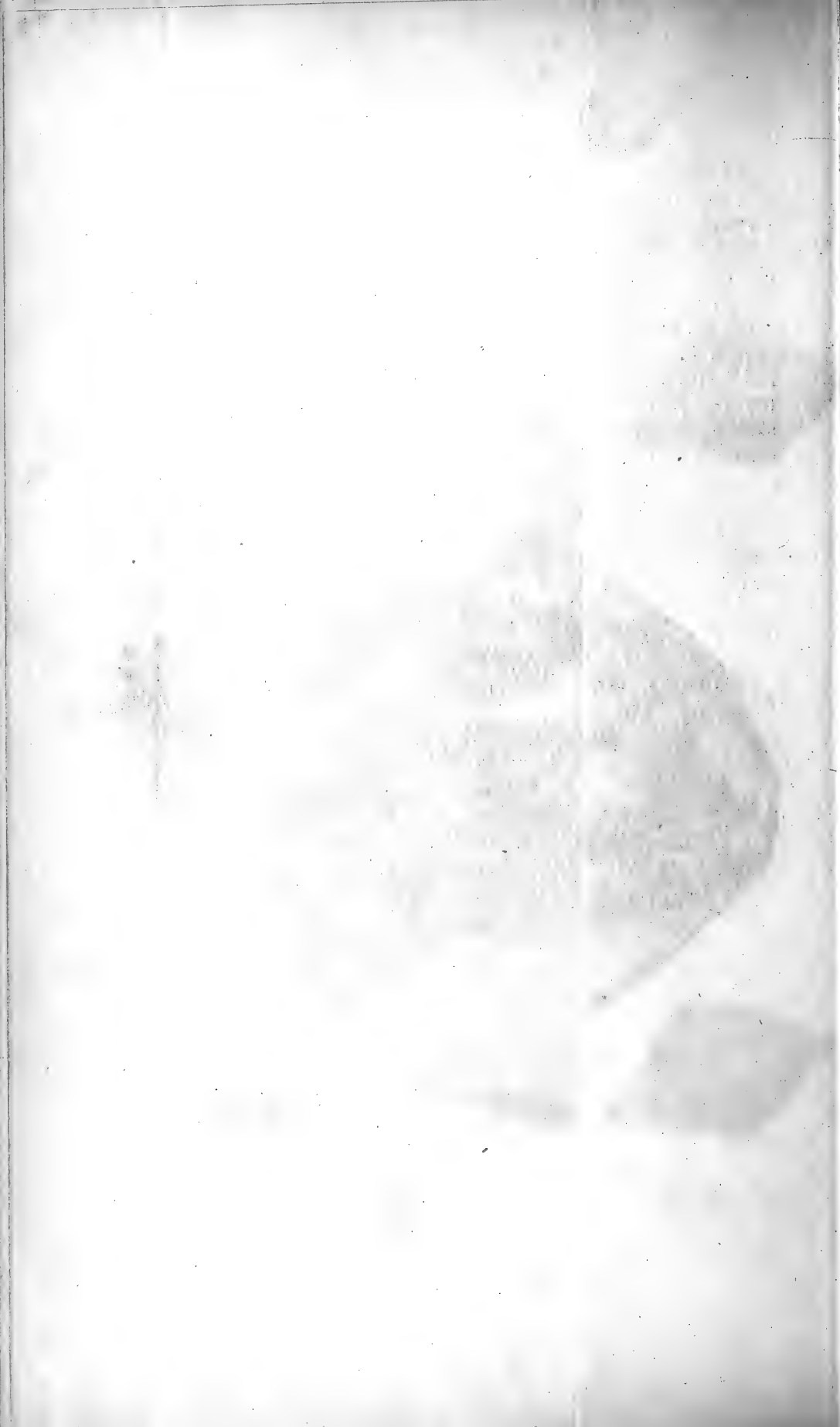
Fig. 2. Tail of another specimen.

Fig. 3. Outer surface of scales, magnified.

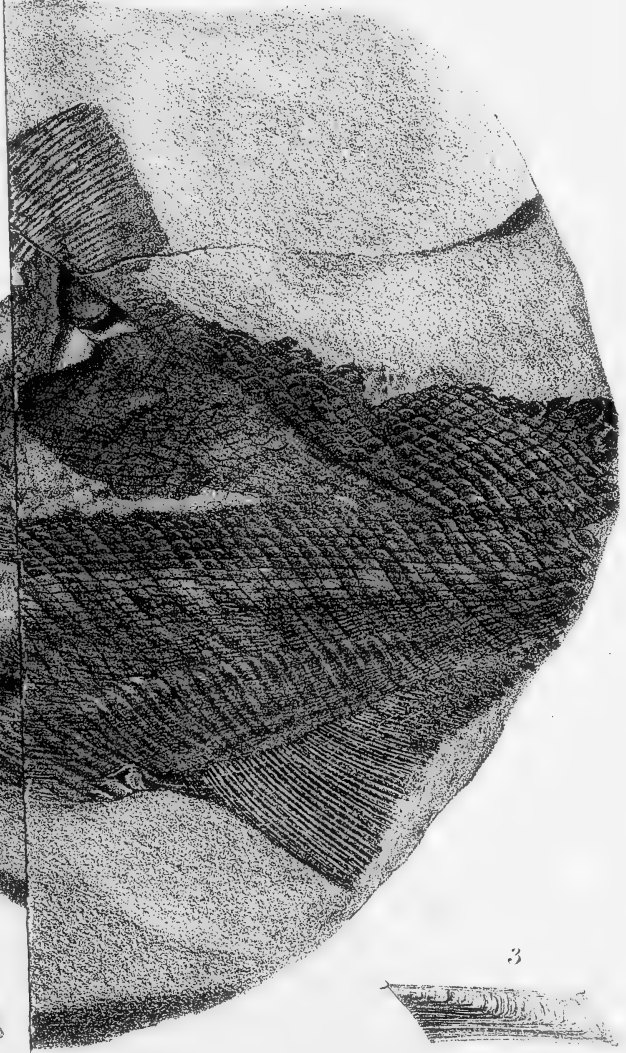
Fig. 4. Inner surface of scale, magnified.

P. DE M. GREY EGERTON.

February 1857.



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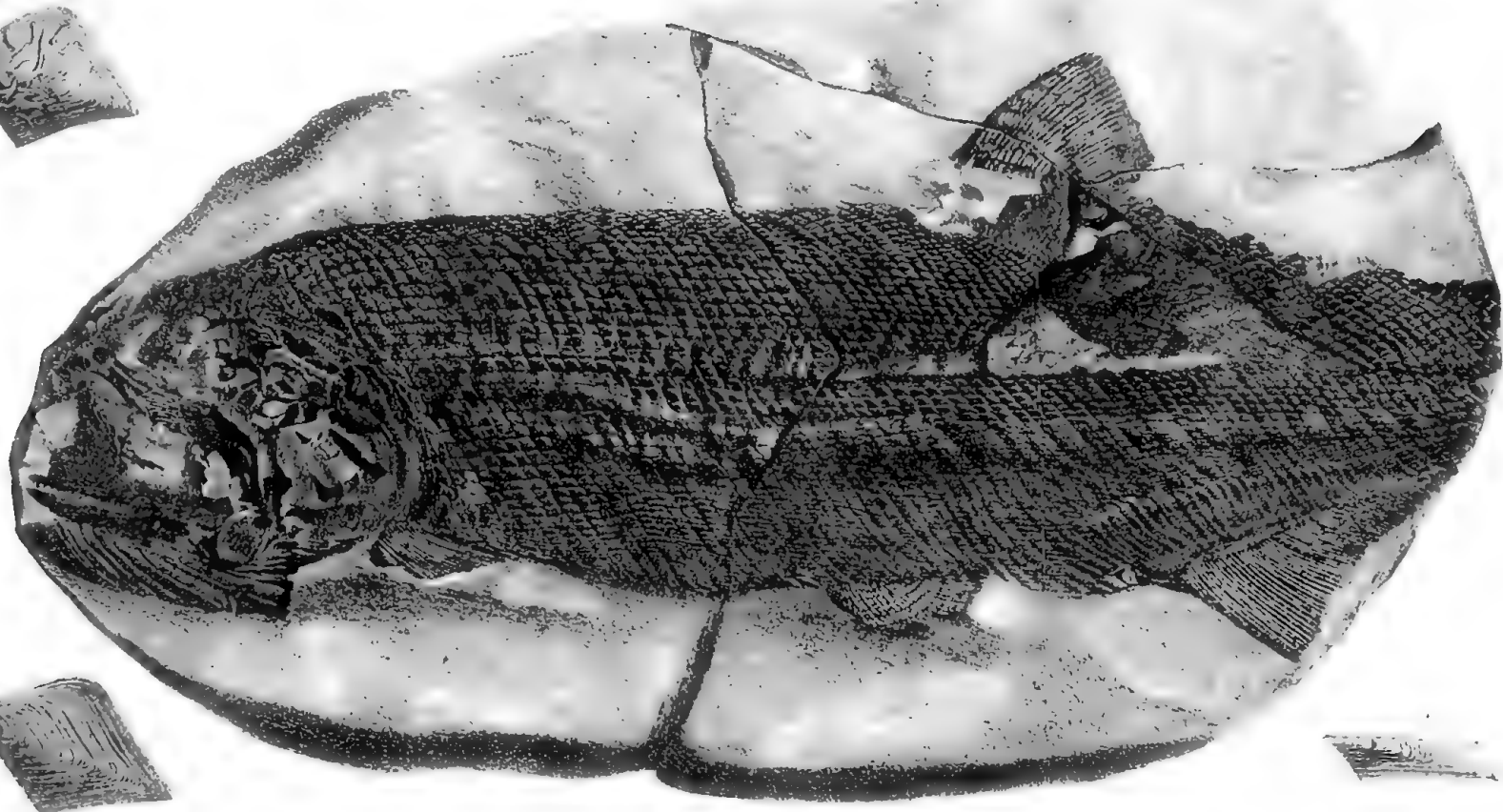
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Survey of the United Kingdom.

1849.
LONDON: G. & C. B. CLAY.



THRISSENOTUS COLEI Agassiz



BRITISH FOSSILS.

DECADE IX. PLATE II.

THRISSENOTUS. GEN. NOV.

[THRISSENOTUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st Group, tail forked.) Body elongated; dorsal fin opposite the interspace between the ventral and anal fins; anal fin extended; scales rhomboidal, small, ganoid.]

Thrissenotus Colei. AGASSIZ. Poiss. Foss. vol. 2, part 2, p. 128.

The tapering head, gracefully elongated body, and well proportioned fins combine to render this the most elegant of the sauroid fishes of the liassic period. The specimen, which is unique, was discovered many years since, and is in the possession of Lord Enniskillen. The generic and specific appellations were given by Professor Agassiz, who alludes to this specimen in the following paragraph:—"The genus *Thrissenotus* is in some degree intermediate between the genera *Sauropsis* and *Thrissops*. In general appearance it also resembles the *Pachycormi*, but it is decidedly a new type, for the dorsal fin is situated in the middle of the back, and yet it has the extended anal fin of a *Thrissops*." With reference to these affiliations, I may remark, in corroboration of its generic distinction, that the body is more elongated than in the *Pachycormi*, the dorsal fin more distal, and the scales entirely dissimilar both from that genus and *Thrissops*. The extended anal fin resembles that of *Sauropsis* and *Thrissops*, but the dorsal fin is more advanced than in either of these genera, corresponding more nearly in this respect with the dorsal fin of the genus *Oxygnathus*. The scales have the nearest resemblance to those of the latter genus and *Cosmolepis*, but are devoid of the surface ornament common to those genera.

Description.—Lord Enniskillen's specimen, the only one hitherto found, measures ten inches in length. The parts anterior to the eye socket and behind the termination of the anal fin are deficient. The depth is nearly uniform from the nape to the anal fin, being about two inches and a half. Behind the anal fin, the depth is one inch and a half. From the gradual convergence anteriorly of the outlines of the head, it is probable that the muzzle was elongated, after the fashion of an *Eugnathus* or *Sauropsis*. The gape was large, and both jaws were furnished with numerous sharp conical teeth. The branchiostegous rays are flattened, and apparently not so numerous as those of *Pachycormus*. Twelve are distinguishable, of which the middle ones are the broadest. The opercular flap is crescentic in form, and extends some distance behind the line of union of the vertebral column with the occiput. The preoperculum is strong and prominent, and is invested with a thick coat of ganoiné, plicated longitudinally. The surface ornament of the operculum and sub-operculum is finer and more granular in its arrangement, and does not conceal the lines of successive growth running parallel to the free margin of the flap. The pectoral fin is broken off at a short distance from the base. It contains about twenty-six rays; these, as far as they are preserved, are single, without transverse sutures. The rays of all the other fins correspond in being compressed and imbricate. The ventral fin has a few short anterior rays, and about twenty principal ones. They are so closely crowded together, that it is impossible to distinguish the precise number. The rays of the dorsal fin are gracefully curved backwards; they are in number about twenty-four. The transverse joints are at distant intervals. The anal fin is remarkable for its extension towards the tail; it measures one inch and three quarters along the base, and probably contains between fifty and sixty rays. The squamation of *Thrissonotus* is very elegant, with regard both to the shape and beauty of the component parts, and the graceful arrangement of the dorso-ventral lines. The scales are all comparatively small, but vary much in relative size. The largest, as is generally the case, occur in the neighbourhood of the lateral line, and the smallest, on the abdominal region. The former are rhomboidal in form, the latter are long and narrow, resembling elongated parallelograms. The surface ornament is, for the most part, due to the permanence of the successive lines of growth; but, in the anterior part of the body, and especially in the vicinity of the nape, a few small vermicular pro-

jections occur, irregularly scattered over the exposed portions of the scales.

Locality.—Found in a concretion of hard lias at Lyme Regis.

EXPLANATION OF PLATE.

Fig. 1. *Thrissonotus Colei*, size of nature.

Fig. 2. Nuchal scale, magnified.

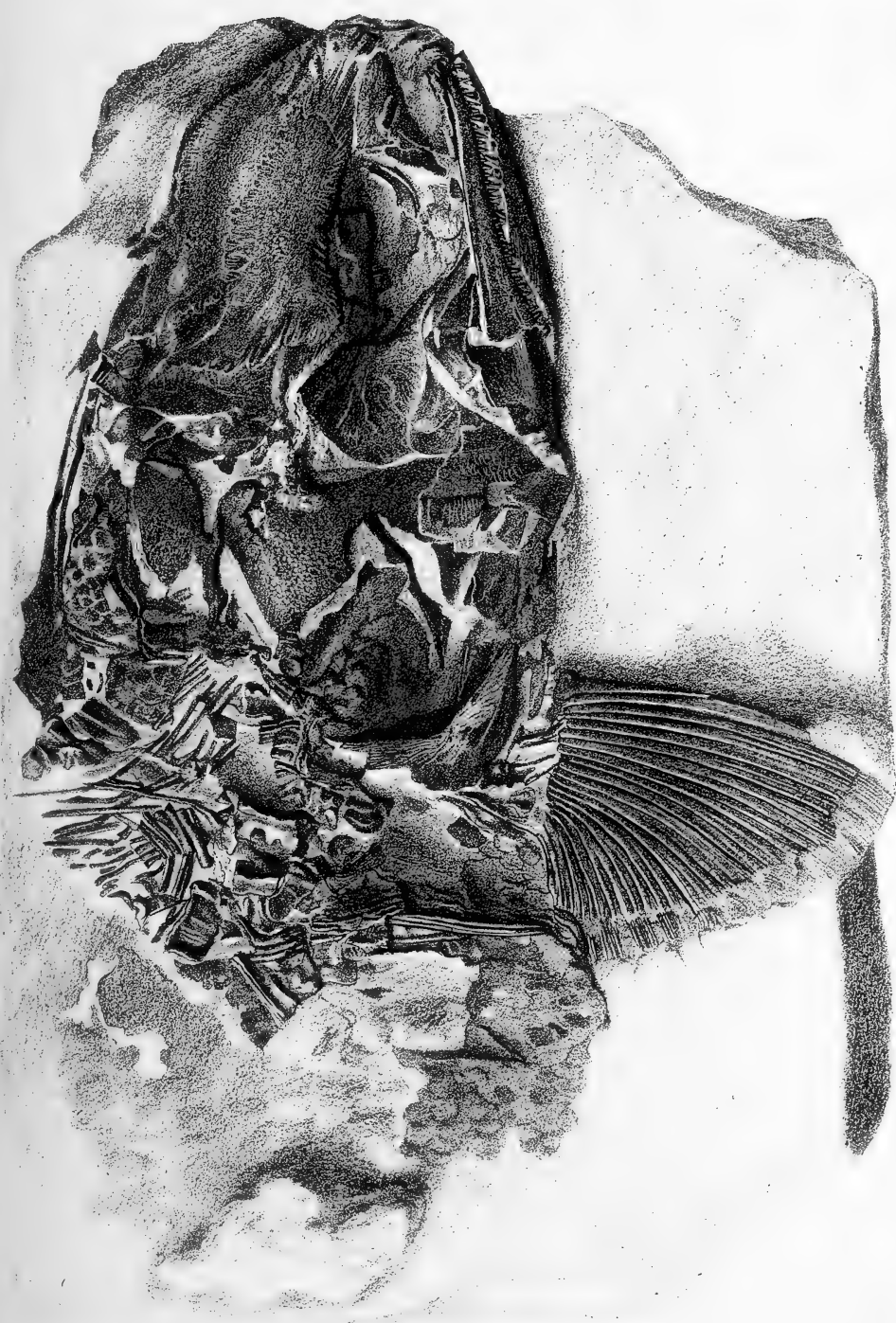
Fig. 3. Abdominal scale, magnified.

Fig. 4. Caudal scale, magnified.

P. DE M. GREY EGERTON.

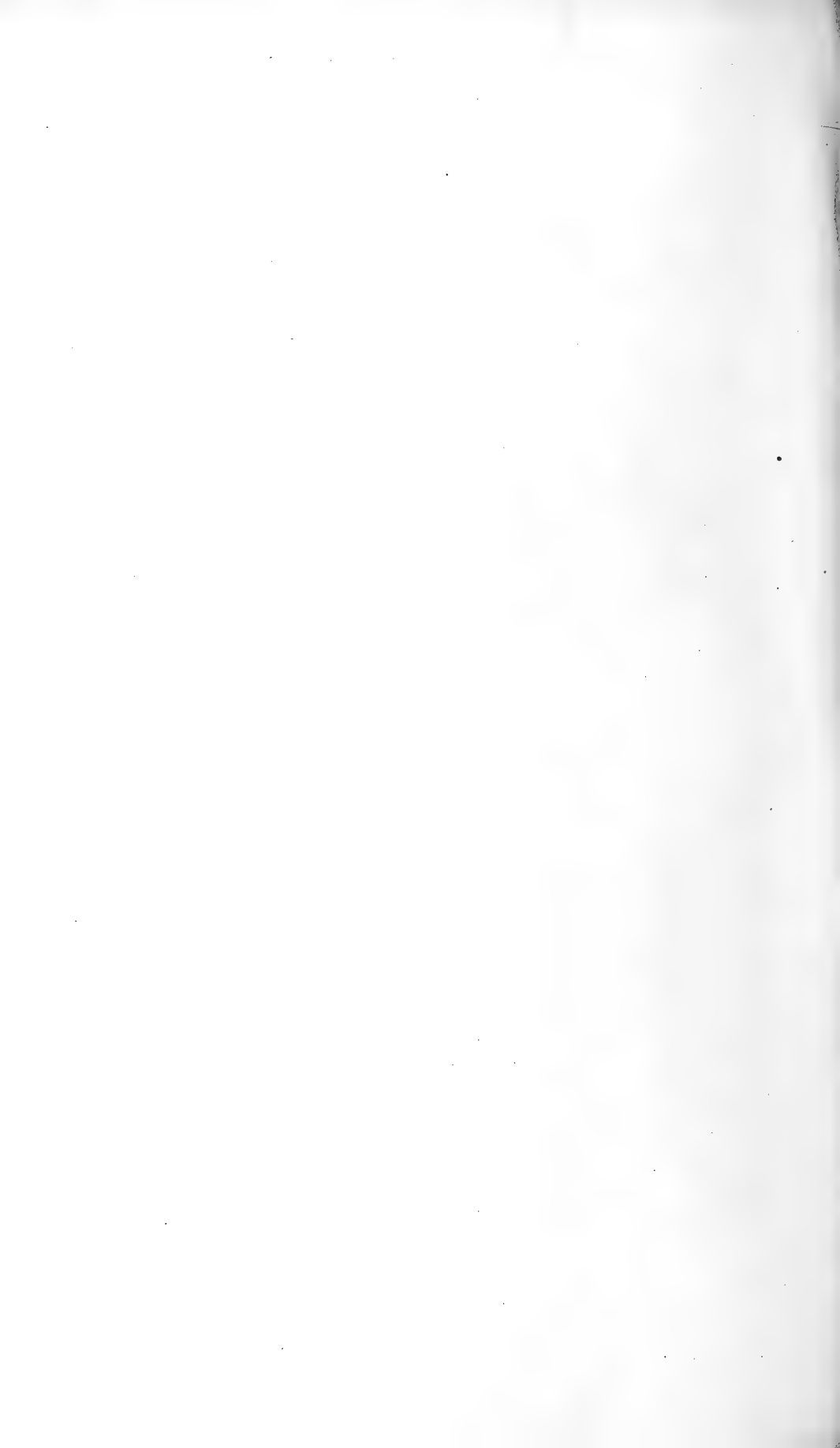
February 1857.





PACHYCORDUS LATIPENNIS. Agassiz.

From the collection of the Academy of Natural Sciences, Philadelphia.



BRITISH FOSSILS.

DECADE IX. PLATE III.

PACHYCORMUS LATIPENNIS.

[Genus PACHYCORMUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st Group, tail forked.) Body deep; vertebræ normal; pectoral fins large; dorsal fin opposite the ventral fins; scales thin.]

Pachycormus latipennis. AGASSIZ. Poiss. Foss. vol. 2. pt. 2. p. 114.

In detailing the generic characters of his genus *Pachycormus*, Professor Agassiz remarks that the dorsal fin is situated opposite to the interspace between the ventral and anal fins. This is strictly the case in the genera *Oxygnathus* and *Cosmolepis*. In *Sauropsis* the dorsal fin is opposed to the anal fin. In *Eugnathus* the large dorsal is inserted opposite the ventral fins, and extends backwards as far as a point coincident with the commencement of the anal fin. In *Caturus* the dorsal fin is opposed to the ventral fins, and in *Pachycormus* its position is intermediate between that of the like fin in *Caturus* and *Eugnathus*. The first ray is immediately over the insertion of the ventral fins, and the after part of the fin stretches a short distance over the interspace between these fins and the anal fin. Of the predacious ganoid fishes of the Liassic period, the *Pachycormi* form an important group, well characterized by their short and deep form, and the delicacy of their scales, features which contrast powerfully with the lanceolate shape and solid scales of the associated *Eugnathi*. Professor Agassiz has only described four species in the "Poissons Fossiles," but he notifies by name several other species as worthy of more detailed examination. Of these the subject I have selected for this article is one of the best characterized, although the specimens hitherto brought to light show only the anterior portion of the fish.

Description.—Of three specimens under notice referable to this species, I select for description the only one seen by Professor Agassiz, and which is therefore the type of the species. It comprises the head, a portion of the scapulocoracoid arch, the pectoral

fin, and a confused mass of scales and vertebræ. The form of the head varies much in this genus. At Whitby, where the species are more numerous than in any other of our British localities, we find a gradation from the small and pointed form of head of *Pachycormus gracilis* and *acutirostris* to the short and deep head which characterizes *Pachycormus latirostris*. Professor Agassiz considers the species under notice to be most nearly allied to the latter species, an approximation which is hardly borne out by a more strict comparison of the two than he was enabled to institute from the materials he had at his disposal. The head of *Pachycormus latipennis* is deeper and broader, and has the snout more blunt than in any other species. It measures four inches in length by two and a quarter in depth; the breadth across the frontal bones is one inch and a quarter. The lower jaw measures two inches and a half in length from the symphysis to the articulating condyle. It is furnished with numerous conical, incurved teeth, varying in size, the largest being situated on the anterior portion of the jaw. The condyloid process is strong, and articulates with a very broad hypotympanic bone. The upper maxillary bone is more slender than the lower jaw; it is dentigerous, the teeth corresponding with those of the lower jaw opposed to them. The large laniary teeth of the latter probably reciprocated with similar teeth on the premaxillary bone and vomer. The frontal bones are broad and very compact in structure. Their surface is covered with slightly elevated sinuous rugæ interspersed with frequent minute punctures, the former prevailing on the posterior, and the latter on the anterior parts of the head. The opercular bones had a somewhat similar surface character, with the addition of a few distant granulations on the upper portion of the operculum. The coracoid bones are very strong, and coarsely plicated longitudinally. The ascending ramus forms nearly a right angle with the lower horizontal branch, this curvature being more abrupt than in other species of the genus. The pectoral fin is very broad, and its constituent rays are flattened as in the genus *Sauropsis*. It differs from the pectoral fin of *Pachycormus latirostris*, in being much shorter and less pointed at the extremity. It contains more than twenty rays. Of these the first is very strong, and single; the succeeding rays remain single for more than half their extent; they then dichotomize, and show frequent transverse joints. In consequence of the great breadth of the constituent rays the surface of the fin when expanded was very large, a character happily seized upon by Professor Agassiz for the specific definition. The

vertebræ, as seen in another specimen, were osseous, the neuropophyses short and slender, and the interneural spines continued over the region anterior to the dorsal fin. In these respects the genus greatly resembles *Caturus*, except that in the latter the vertebral appendages are more robust. The scales are exceedingly thin and overlaid with a very delicate coat of enamel finely sculptured in concentric rings. The free margins were more or less curvilinear, resembling in this respect the scales of *Caturus* and *Leptolepis*.

Locality.—All the specimens of this species hitherto found are from the lias of Lyme Regis.

EXPLANATION OF PLATE.

Pachycormus latipennis, size of nature.

P. DE M. GREY EGERTON.

February 1857.

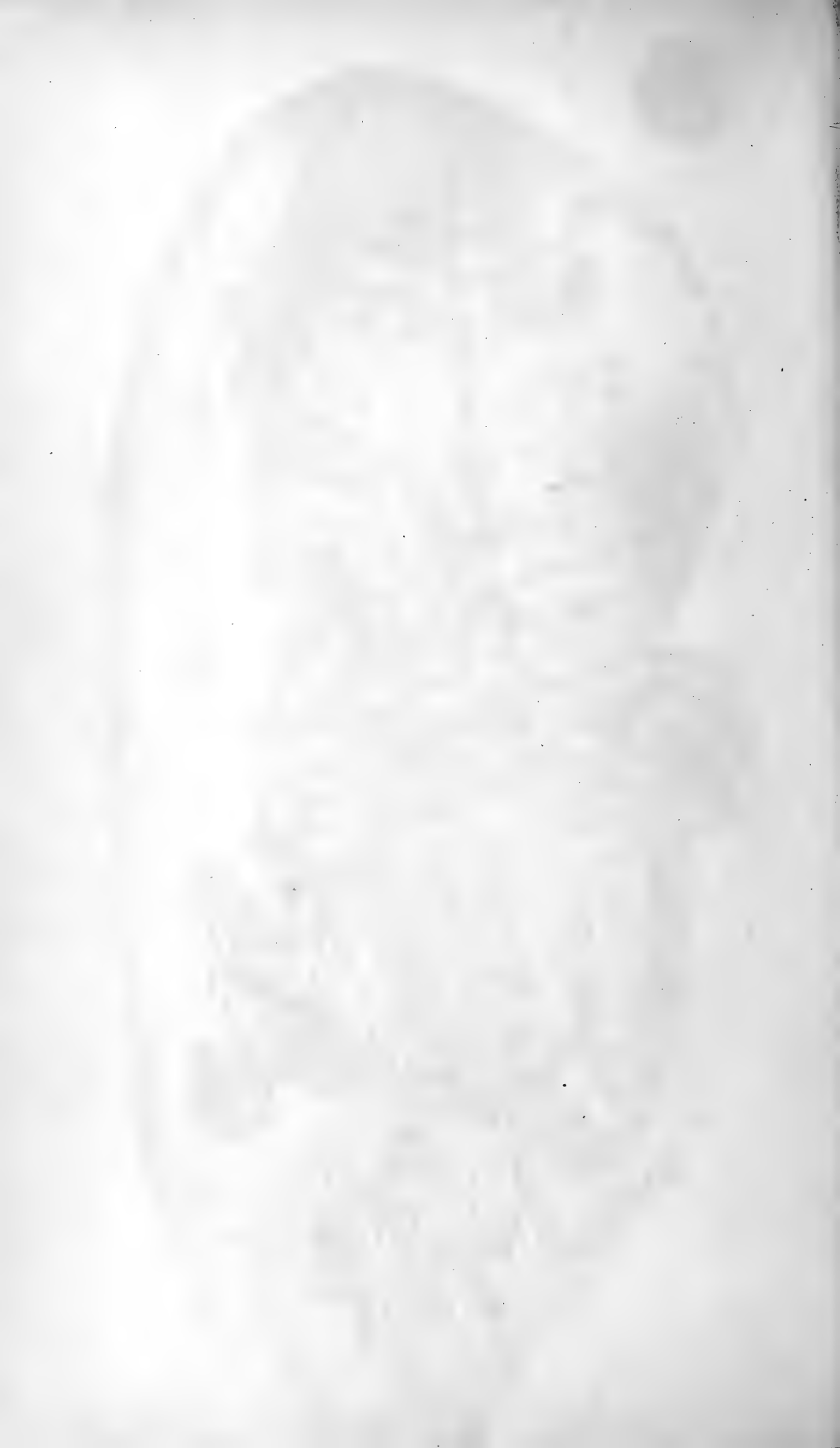
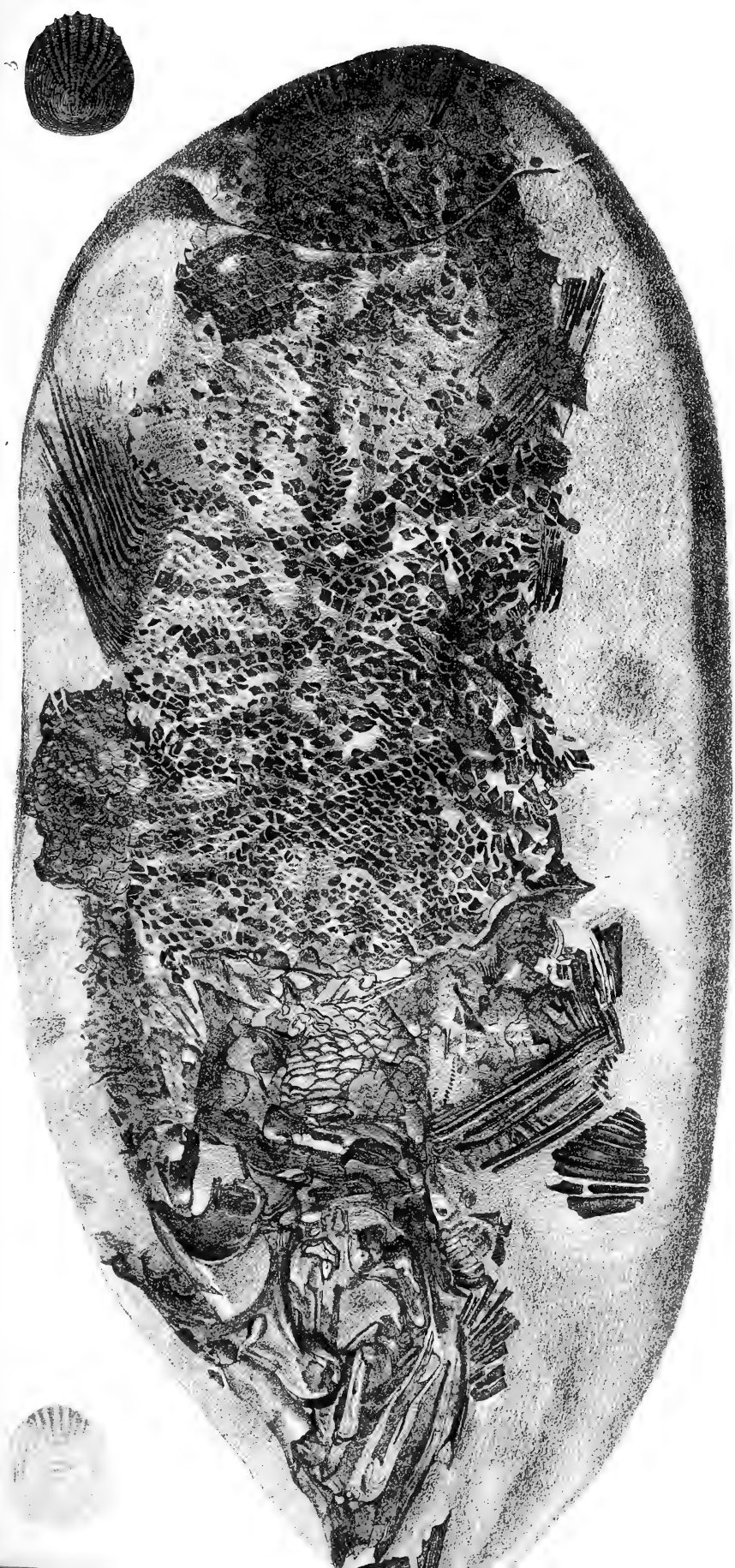
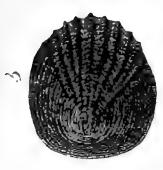


PLATE I. — ENDACTIS AGASSIZI. — EGERTON.

ENDACTIS
(Coluber)

1



2



ENDACTIS AGASSIZI. — Egerton.



BRITISH FOSSILS.

DECADE IX. PLATE IV.

ENDACTIS. GEN. NOV.

[Genus ENDACTIS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st Group, tail forked.) Head small and pointed; dorsal fin opposite the ventral fins; anal fin approximated to the ventral fins; base of the tail deep; scales minute, curvilinear, ornamented with raised surface markings.]

SPECIES UNICA. *Endactis Agassizi*.

The subject of the following description is the last fossil fish named by Professor Agassiz before his departure for the United States. I had incorporated it in my cabinet as a new species of *Pachycormus*, but his discriminating eye detected evidences of generic discrepancy which induced him to make it the type of a new genus, which he called *Endactis* from the peculiar character of the scales. It certainly is very nearly allied to the *Pachycormi* in general figure, and in the arrangement of the fins; the most evident distinctions being the larger size of the dorsal fin, the greater thickness of the caudal pedicle and the surface ornament of the scales. It is, perhaps, hazardous to trust to characters so slight, and to the evidence of a single specimen, and that an imperfect one for generic isolation; the more so when we find some of these characters variable and considered as of only specific value in the several species of *Pachycormus* with which we are acquainted. A very important element for deciding the question is unfortunately deficient, namely, the caudal fin. One of the most striking and constant peculiarities of the genus *Pachycormus* is a very large and deeply cleft caudal fin springing from a narrow pedicle, caused by the rapid contraction of the dimensions of the after part of the trunk. This contraction is much less rapid in *Endactis*, as far as the specimen shows, and I am inclined for this reason to believe that future discoveries will reveal a form of caudal fin which will substantiate this as a generic type. Should it prove otherwise, the genus must lapse, but there is no doubt

whatever but that the species is distinct from all the *Pachycormi* hitherto discovered.

Description.—The species of *Pachycormus* to which *Endactis* has the nearest resemblance is *Pachycormus curtus*, from the lias of Whitby. The figure given of this species in the “Poissons Fossiles” represents a fish nine inches in length by three inches in depth. The specimen under description is also nine inches in length, but was probably an inch longer when perfect; the depth is only two inches and three quarters. The diameter of the caudal pedicle at a corresponding point in the two specimens is one inch in *Pachycormus curtus* and two inches in *Endactis*. The dorsal fin in the latter is longer and the rays thicker, and the ventral and anal fins are more approximated. Compared with *Pachycormus gracilis*, the body is shorter and the head comparatively smaller. It has no resemblance to any species of *Pachycormus* found associated with it in the Lyme Regis beds. The bones of the head are much crushed, and the operculum is thrown upwards from its position; the latter disturbance makes the head appear larger than it is in reality. It is in fact small for the size of the fish. In form it approaches that of an isosceles triangle, the lines of the forehead and lower jaw being very slightly curved, the snout forming the apex of the figure. The mouth is large, the lower jaw measuring an inch and a half in length. The teeth are wanting. The branchiostegous rays are numerous. Judging from what remains of the pectoral fin, it probably corresponded in size and structure with the analogous organ of *Pachycormus*. The dorsal fin is situated six inches from the snout, and is immediately over the insertions of the ventral fins. It contains at least twenty rays. Of these the four or five anterior ones are single, and increase consecutively in length. They are, however, true rays, carried upon interneural spines, and not fulcral scales. The principal fin rays are transversely jointed at rather distant intervals. The ventral fins are small and indistinct. The anal fin commences one inch and a half behind the attachment of the ventral fins. The interhæmal spines supporting the anterior rays of this fin are very strong. The fin rays are thicker than in any of the *Pachycormi*. The number cannot be discerned, but those that remain correspond in character with the dorsal fin rays. The scales are very numerous. In the neighbourhood of the scapular arch they are rhomboidal, with the posterior angles slightly rounded. In the afterpart of the fish they become curvilinear. They are invested with a thin layer of enamel, on the surface of which an elegant pattern is produced

by a series of fine diverging rays rising in relief and radiating outwards towards the posterior margin of each scale. A somewhat similar ornament is seen in some species of *Eugnathus*, but no instance has occurred of its presence in any species of *Pachycormus*. Professor Agassiz gave no specific name to this specimen; I therefore dedicate it to him in grateful remembrance of the last of the many happy days it was my good fortune to enjoy in his society.

Locality.—Lias of Lyme Regis, Dorset.

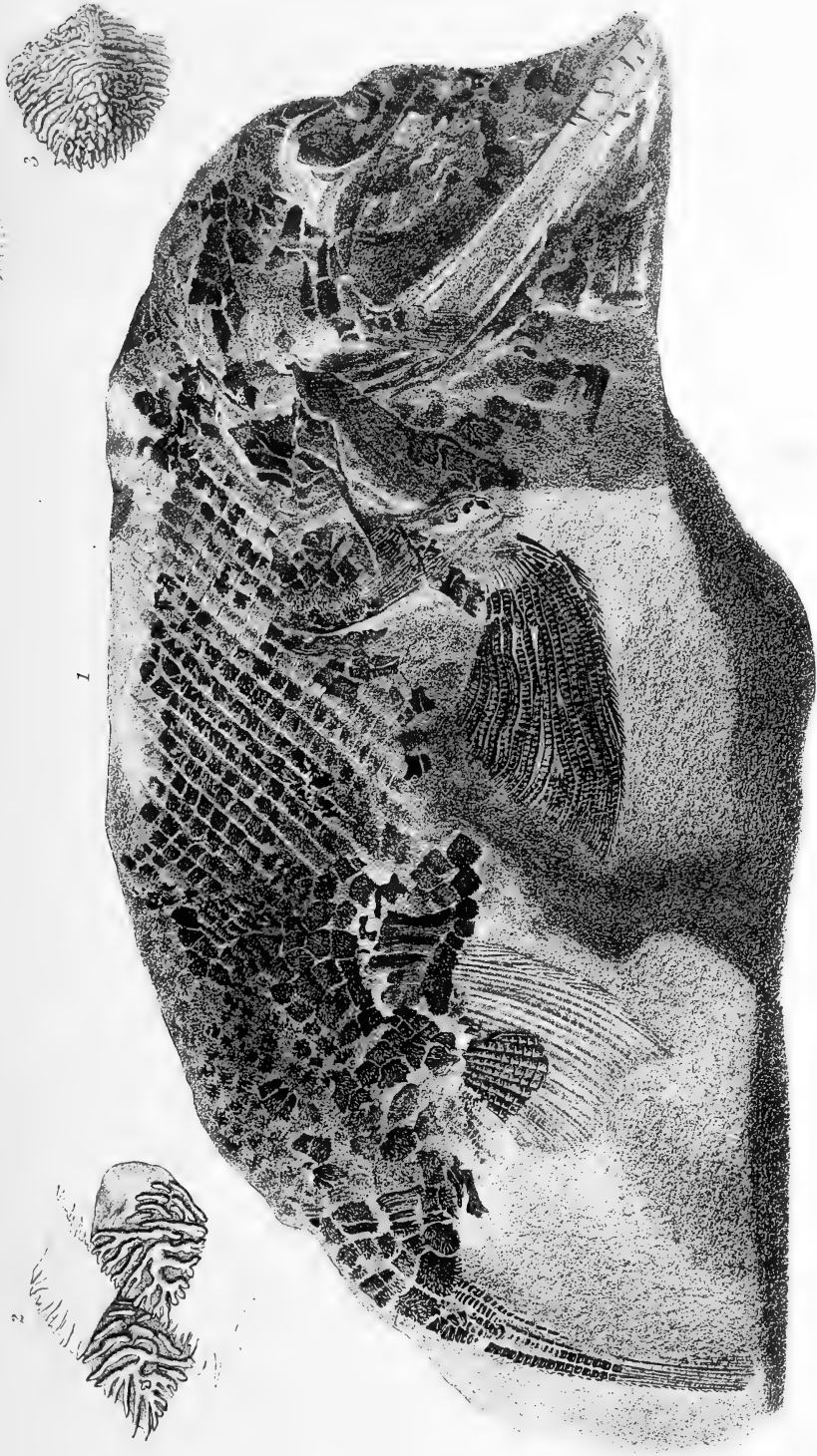
EXPLANATION OF PLATE.

Fig. 1. *Endaetis Agassizi*, size of nature.

Figs. 2 and 3. Scales magnified, outer view.

P. DE M. GREY EGERTON.

February 1857.



CENTROLEPIS ASPER . Egerion.



BRITISH FOSSILS.

DECADE IX. PLATE V.

CENTROLEPIS. GEN. NOV.

[Genus CENTROLEPIS (*κεντρον, calcar; λειψ, squama*). EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci.) Head large; teeth conical; body short; pectoral and anal fins very broad; scales rhomboidal, rugose, with strong spurs on the posterior margin.]

SPECIES UNICA. *Centrolepis asper*. Poiss. Foss. vol. 2. p. 304.

Walking, many years ago, with Lord Enniskillen, on the beach under Black Ven, to the eastward of Lyme Regis, we met a well-known character, by name Jonas, who had just split open a lias nodule which contained a fossil fish. The specimen changed ownership for a few shillings, and from that day I have in vain searched for another fragment to elucidate the affinities of this most singular fish. The family to which it appertained was for some years doubtful. Professor Agassiz, who examined it more than once, was inclined to refer it to the Lepidoidei. More recently, by delicate manipulation, the form of the jaws and characters of the teeth have been discovered, and they unquestionably betoken its affinity to the Sauroidei.

Description.—The distorted position of the fish, and the deficiency of the dorsal portion, render the restoration of the actual proportions a matter of conjecture. The head is large, and the mouth especially so; the body short, and the pectoral and anal fins unusually broad. It is fair to presume, from these features, that the depth of the fish was considerable, and the dorsal fin large. By restoring the head to its natural position, the length of the fish from the nose to the base of the tail is ascertained to be seven inches. Of this dimension the head occupies nearly three inches. The cranial bones are dense, and are ornamented externally with a raised pattern, varying from a granular to a ridge and furrow figure. On the opercular flap the pattern is less prominent, and is associated with what appear to be lines of successive growth, corresponding with the existing outlines of the constituent plates. The mouth measures two inches in length. The teeth are numerous, sharp, and conical; the intervals between the larger ones being beset with smaller ones. No fish of the Lepidoid family has the dental apparatus similarly

constituted. The pectoral fins are composed of numerous broad flattened rays. They have frequent transverse joints, and are remarkable for having their surface invested with a corrugated layer of ganoine, corresponding in character with that covering the head bones and scales. This character is common to all the fins. The only similar instance I am acquainted with occurs in the genus *Platysomus*. The first pectoral ray is fringed with scales on its anterior border. The position of the ventral fins is seen about midway between the pectoral and anal fins; the fins themselves are defective. The space between the pectorals and the anal is so confined that the ventral fins were probably of small dimensions. The anal fin is very large, and the rays composing it unusually long. The first ray has fulcral scales and a fringed margin; the subsequent rays are flattened, expanded, and transversely jointed at short intervals; in number they cannot have been fewer than thirty. A few rays of each lobe of the tail are preserved; the multiplication of the transverse articulations is the most striking peculiarity they present. A single broad scale occurs at the base of the lower caudal lobe, but beyond this no fulcral scales seem to have existed in this region. The scales are unlike any I have elsewhere met with; they are rhomboidal, of medium size, and extremely solid. The exposed surface is covered with coarse rugæ, arranged, not, as is commonly the case, in the longitudinal direction, from the anterior to the posterior margin of the scales, but transversely. The free edges of the scales are armed with strong spurs. On the under surface the scales are smooth, and destitute of the midrib so common in the generality of the Sauroid genera. The substance of the scales is so thick that the strong articulating processes of the upper margins are formed out of the uniform thickness of the scales themselves, the extra material provided by the midrib not being requisite. I am not without hopes that the publicity given to what is already known respecting this genus may be the means of bringing to light other specimens, to complete the anatomical details of this most interesting form.

Locality.—Lias of Lyme Regis.

EXPLANATION OF PLATE.

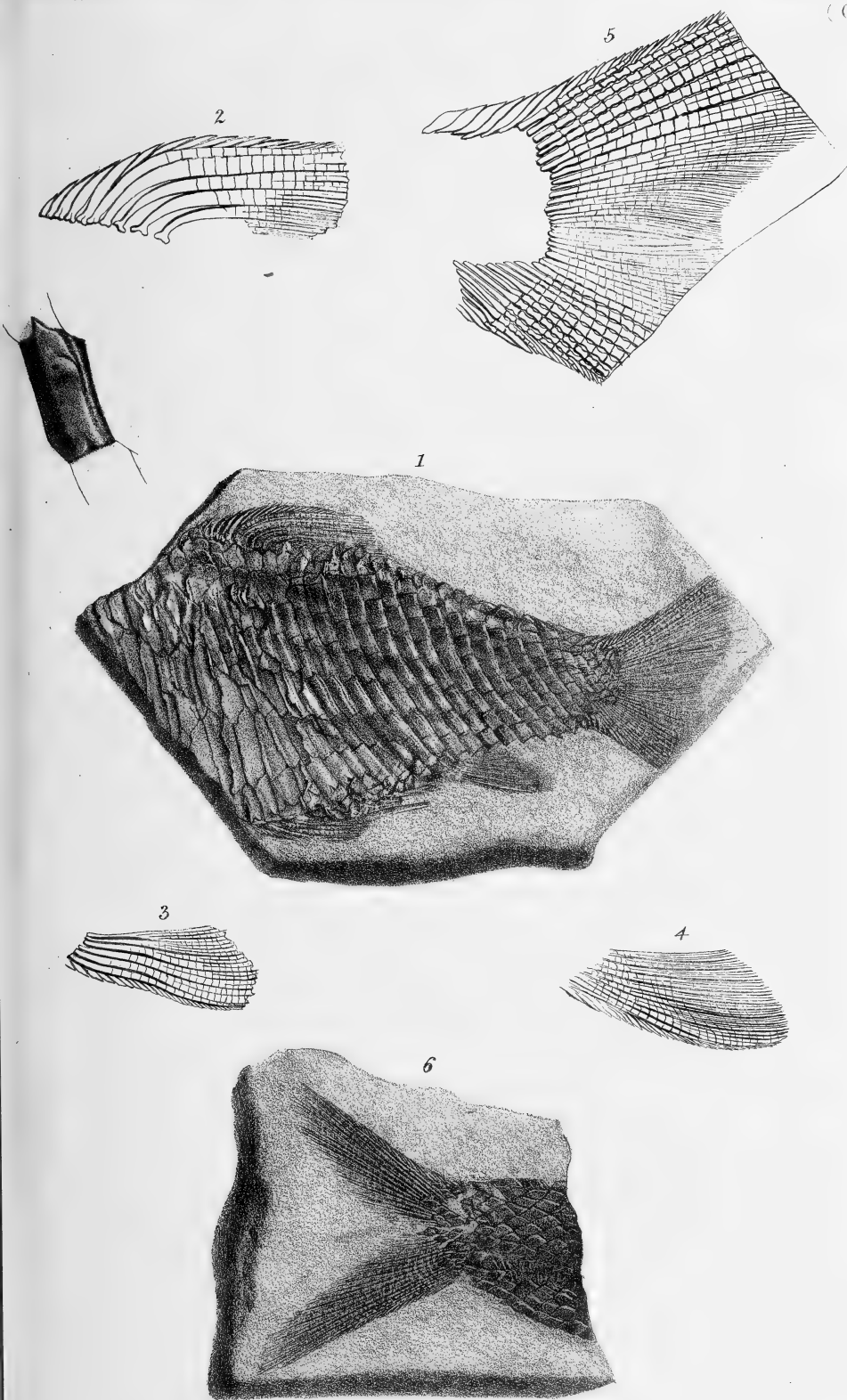
Fig. 1. *Centrolepis asper*, size of nature.

Fig. 2. Scales, magnified.

Fig. 3. Caudal scale, magnified.

P. DE M. GREY EGERTON.

February 1857.



NOTHOSOMUS OCTOSTYCHIUS. — *Agassiz*.



BRITISH FOSSILS.

DECADE IX. PLATE VI.

NOTHOSOMUS. GEN. NOV.

[Genus NOTHOSOMUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolenipodoti. Family Lepidostei. Sub-family Lepidostei homocerci. 2nd Group, body elongated, more or less fusiform.) Fins small, with fulcra on the first rays. Caudal fin forked. Scales smooth; four rows of broad scales on the flanks.]

Nothosomus octostychius. AGASSIZ. Poiss. Foss. vol. 2, page 292.

The genus *Nothosomus* is notified in the "Recherches sur les Poissons Fossiles" of Agassiz in the following terms:—"After the genus *Ophiopsis* must be placed a new generic type, which I have distinguished by the name *Nothosomus*, and which is characterized by a long dorsal fin and scales higher than broad." The specimen from which the genus was established was found in the Lias at Street, and presented to me by Mr. Hawkins. It only shows the posterior half of the fish, but as it is the type of the genus, and so far as I am aware the only example of it which has yet been found, it is worthy of being described, the more so that in consequence of the brief notice of Professor Agassiz, it has been quoted by other authors, and is included in all the catalogues of liassic fossils.

Description.—The specimen is broken off immediately in front of the dorsal fin, and the anterior portion is wanting. What remains is, however, in a good state of preservation, and exhibits the dorsal, ventral, anal, and caudal fins, together with the scales of the right flank seen from within. A few impressions of the outer surface of the scales are seen in the anterior part of the specimen. The dorsal fin is situated a little in advance of a perpendicular line extended from the attachment of the ventral fins; the anal fin is inserted about midway between the ventrals and the base of the tail. The interspace between the first ray of the dorsal fin and the upper lobe of the caudal fin measures two inches and a half, and from the ventral fin to the lower lobe of the tail two inches and one tenth. The depth of the trunk from the dorsal fin to the ventral fins is one inch and three quarters; from this point to the spring of the caudal fin, where the diameter is half an inch, the contraction is very regular. In these details *Nothosomus* bears

a close resemblance to *Pholidophorus*, and should the positions of the fins in relation to the anterior parts correspond, the general form of the fish would come very near that of one of the shorter and deeper species of that genus. There is also an approximation in the character and mechanism of the scales, and I am therefore inclined to place the genus next to *Pholidophorus*, rather than after *Ophiopsis*, as suggested by Professor Agassiz. The locomotive organs differ essentially from both these genera. In advance of the dorsal fin are five strong fulcral scales, and the first true fin ray has a fringe of short spines along the anterior border. The true rays are six or seven in number, curving backward from their insertions. They are stronger than the fin rays of *Pholidophorus*, and differ also in having the transverse articulations more numerous, and continued nearly to the base of the component rays. The distal extremities are finely fimbriated. The ventral fin contains six rays, more slender than those of the dorsal fin. The anterior one is similarly fringed. The anal fin is composed of twelve rays at least, but they are inserted so closely together, that the exact number cannot be ascertained. The anterior ray is bordered in unison with the corresponding member of the dorsal and ventral fins. The component rays are extremely slender and delicately fimbriated in their distal parts. All the fins, although small with reference to the size of the fish, are comparatively larger than the corresponding organs of *Pholidophorus*; they differ also materially in having bordered margins, and being transversely subdivided to a much greater extent. The caudal fin is deeply forked. The upper lobe contains sixteen rays; the lower one is composed of a like number. Both upper and lower margins are fringed, and a few strong fulcral scales occur at the base of each. The body scales extend rather further on the upper lobe than on the lower. The styles supporting the rays are short and slender, and of equal length in each lobe; in the tail of *Pholidophorus*, the styles of the upper lobe are very considerably longer than those of the lower lobe. The fin rays are stronger in the upper lobe than in the lower. The transverse articulations occur at shorter intervals than in the tail rays of *Pholidophorus*; in the lower lobe the divisions of the ossicles are so nearly coincident that they form continuous elevated lines sweeping across the fin, while in *Pholidophorus* and the allied genera, the articulations of one ray generally impinge between the articulations of the adjoining ray. The result of this arrangement, combined with the frequency of the sub-divisions of the rays of this and the other fins, would be to afford a greater amount of

lateral flexure in the organs of locomotion in *Nothosomus*, while the necessary support was provided for by the fulcral scales and strengthened borders of the anterior rays. The dorso-ventral series contain eight scales, slightly inclined backwards. The mucous duct pierces the third row from below, this being the position of the largest scales; the row next below it being the next also in size. These and the two rows above the lateral line are considerably larger than those above and below, until near the region of the tail, where all the scales are nearly uniform in size. The scales are thick, compact, and highly lustrous. The outer surface is smooth, and the free margins entire. The inner surface is provided with a broad perpendicular band, occupying the centre of the scales on the flanks, but extending over the entire inner area of the caudal scales. Each band terminates above in a strong pointed process, which locks into a corresponding depression on the lower margin of the scale next above it. Receding towards the tail, these processes become gradually more and more obtuse, until they disappear altogether, and the few most distal scales are united by apposition of the broad margins of the bands. In *Pholidophorus* and the allied genera the scales covering the centre of the flanks are commonly larger than those on the upper and lower margins of the body; but there is always a more or less graduated passage from the one form to the other, by the interposition of scales of intermediate dimensions, even in *Pholidophorus pachysomus*, where the extremes are most exaggerated. The details above given show that in *Nothosomus*, the flanks are protected by four rows of large scutiform scales, succeeded above and below by small scales, the transition from the one form to the other being abrupt. In this respect *Nothosomus* has some resemblance to the sauroid genera *Aspidorhynchus* and *Belonostomus*, but in all other respects it appears to be a legitimate member of the Lepidoid family.

Locality.—The Lias of Street, Gloucestershire.

EXPLANATION OF PLATE.

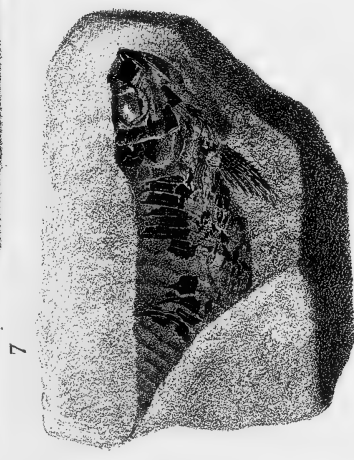
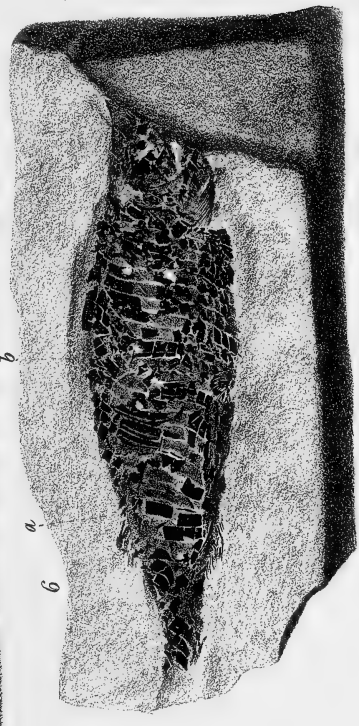
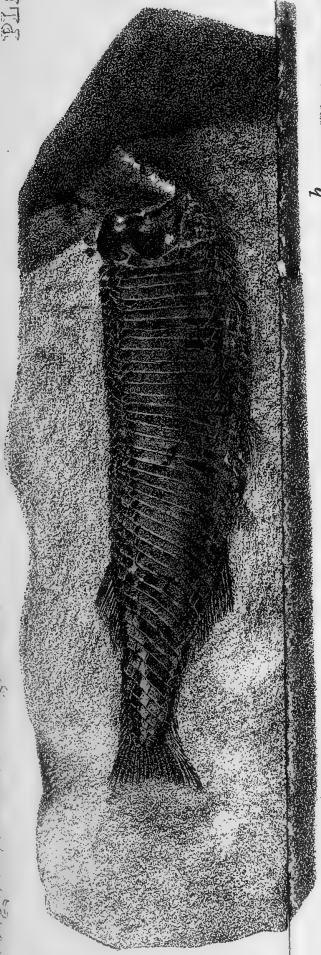
- Fig. 1. *Nothosomus octostychius*, size of nature.
- Fig. 2. Dorsal fin, magnified.
- Fig. 3. Ventral fin, magnified.
- Fig. 4. Anal fin, magnified.
- Fig. 5. Caudal fin, magnified.
- Fig. 6. Tail of *Pholidophorus*, magnified.

P. DE M. GREY EGERTON.

February 1857.

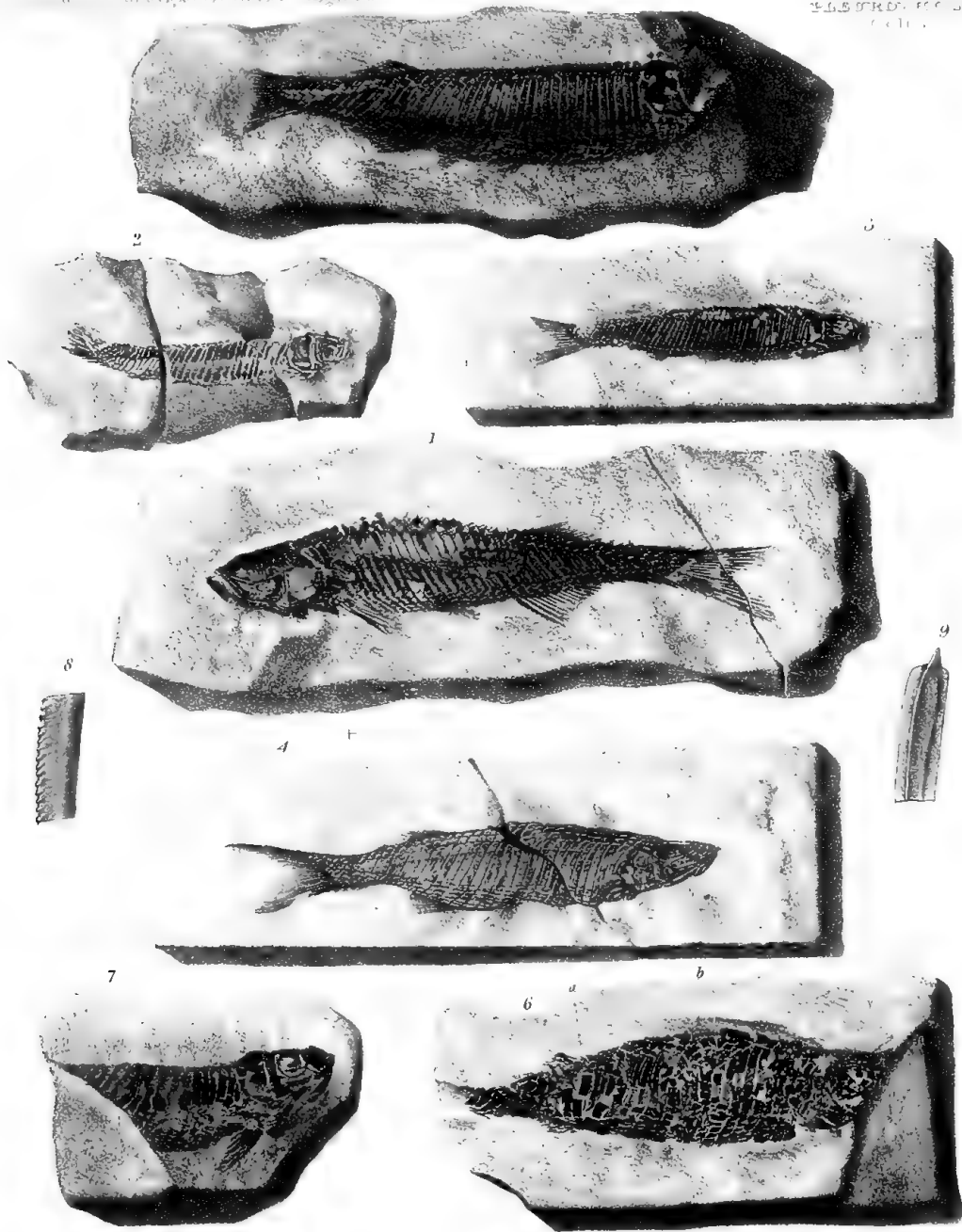


PECAIDIUM
PLEUROPHOLIS,
(Ochitic.



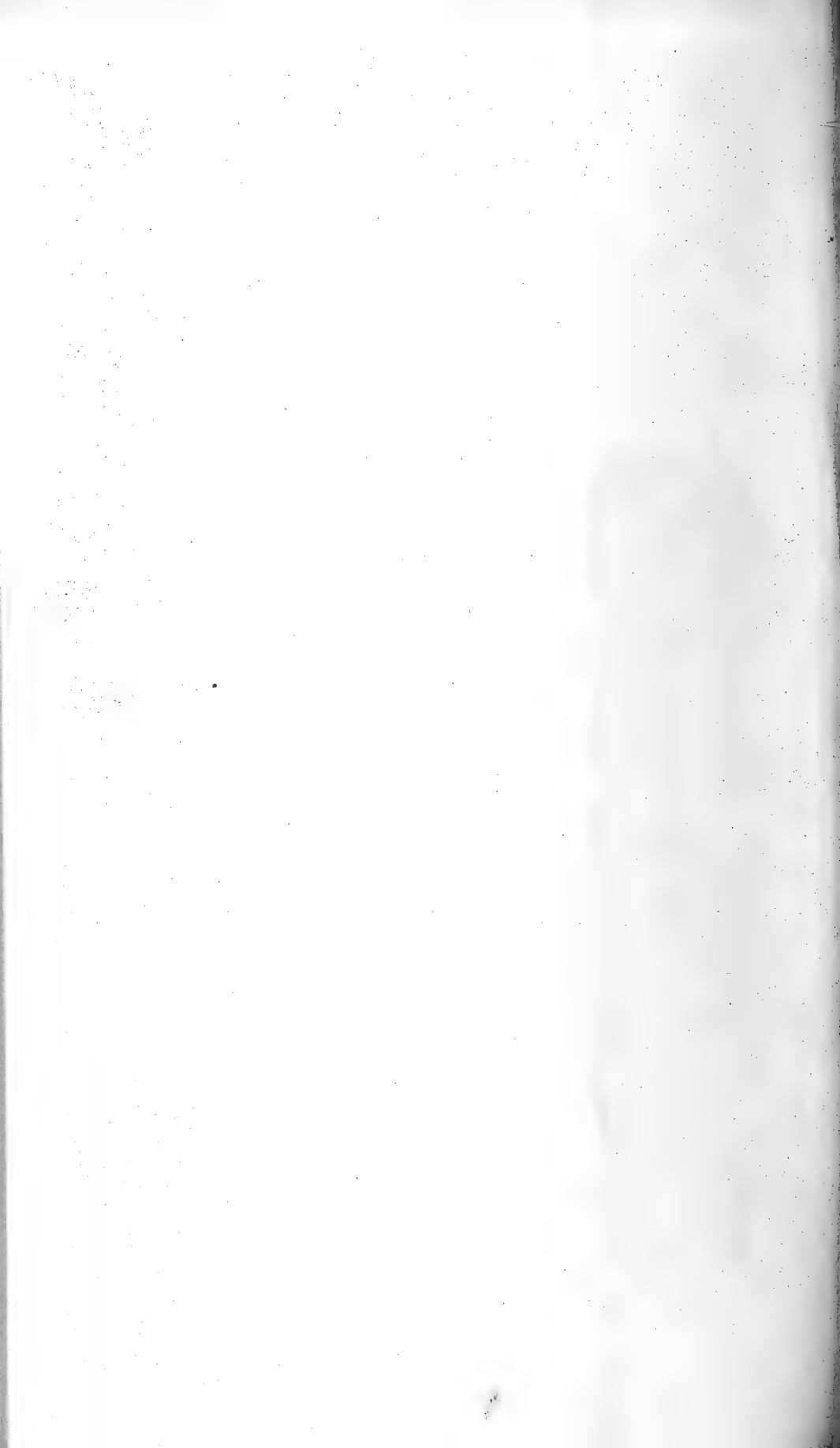
- 1 PLEUROPHOLIS ATTENUATUS. *Egerton.*
- 2 PLEUROPHOLIS CRASSICAUDUS. *Egerton.*
- 3 PLEUROPHOLIS LAEVISSIMUS. *Agassiz.*
- 4 PLEUROPHOLIS LONGICAUDUS. *Egerton.*
- 5, 6, 7. PLEUROPHOLIS SERRATUS. *Egerton.*
- 8, 9. SCALES *a, b* magnified.

PLATE 10



1 PLEUROPHOLIS ATTENUATUS Egerton
 2 PLEUROPHOLIS CRASSICAUDUS Egerton
 3 PLEUROPHOLIS LAEVISSIMUS Agassiz

4 PLEUROPHOLIS LONGICAUDUS Egerton
 5 6 7 PLEUROPHOLIS SERRATUS Egerton
 8 9 SCALES *a b* magnified



BRITISH FOSSILS.

DECADE IX. PLATE VII. FIG. 1.

PLEUROPHOLIS. GEN. NOV.

[Genus PLEUROPHOLIS. *πλευρα*, the side; *φολις*, a scute. EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Goniopodoti. Family Lepidostei. Sub-family Lepidostei homocerci. 2nd Group, body elongated, more or less fusiform.) Caudal fin forked; dorsal fin opposite the anal fin; anal fin extended; head small; body slender; scales of the flanks arranged in a single series.]

Pleuropholis attenuatus. MORRIS. Cat. Brit. Foss., 1854.

I propose the generic designation *Pleuropholis* for a small group of fishes of diminutive size and limited geological range, but possessing characters singularly well defined and very distinct from those of any genus of fossil fishes hitherto described. In the form of the head, the position of the mouth, and general outline of the body, they somewhat resemble a small *Thrissops* or *Leptolepis*. The arrangement of the fins also corresponds to some extent with that of those organs in the former genus. The characters of the tail resemble those of *Ophiopsis*. The dermal peculiarities, however, are so remarkable that they forbid the association of *Pleuropholis* with any known genus. If we except the isolated family of the *Acanthodei*, the multiplication of the scales in the dorso-ventral series is greatest in the genera *Pachycormus*, *Endactis*, and *Cosmolepis*. In the latter we find not less than sixty scales in each series on the anterior and middle regions of the trunk. In *Nothosomus* the number is reduced to eight, and in the sauroid genus *Aspidorhynchus* the flanks are protected by large scutes, the dorso-ventral series being completed above and below by a few scales of much smaller dimensions. These characters are subject to occasional variations in the latter genus, and the single scutes are sometimes replaced by two or three scales. In *Pleuropholis* the dorso-ventral series are also composed of a single row of scutes, completed above and below by a few small scales, the latter being more numerous in the caudal region. In this respect it resembles the cretaceous genus *Priono-*

lepis. I am cognizant of several species, probably referable to this genus, all of which will be noticed in the sequel.

Description.—The beautiful little fish which I have selected as the type of the genus was found by Mr. Bristow in the Middle Purbeck beds at Apsel Lane, north of Sutton Mandeville. It measures two inches in length from the nose to the extremity of the tail, by three-tenths of an inch in depth. The latter measurement is taken at a point midway between the pectoral and anal fins, from which point the body tapers symmetrically to the tail. The head measures four-tenths of an inch in length. The mouth is small and opens upwards, as in *Thrissops* and *Leptolepis*. The relative size and position of the orbit correspond also with these genera. The opercular bones are of moderate size and smooth exterior. The rays of the pectoral fin are strong in relation to the size of the fish. Their number cannot be ascertained. The ventral fins are small, and situated midway between the pectoral and anal fins. The dorsal fin commences at a point two-thirds of the distance from the nose to the fork of the tail. It contains ten delicate rays, single for half their length, and then bifurcated and transversely articulated. They are preceded by a few elongated fulcral scales. The anal fin is opposed to the dorsal fin. It contains twelve rays, rather distant from each other. They correspond in character with those of the dorsal fin. The anterior ray is bordered, a character probably also common to the dorsal fin. The caudal fin is deeply cleft. The upper lobe is invested with scales at its base, and contains nine principal rays, closely set at their insertion. The lower lobe, is also composed of nine rays, more distant from each other than those of the upper lobe. All the rays have frequent transverse joints, more numerous on the lower than the upper lobe. The borders of both are fringed with fine elongated fulcral scales. The scales are smooth. Those on the back, belly, and tail are small and lozenge-shaped. The remainder of the body is covered with a single row of high, narrow scutes, inclining backwards and downwards in slightly sigmoid curves; each scale has a broad elevated band extending from the apex to the base of the inner surface (fig. 9). It is broader above than below, and terminates upwards in a short process, which connects it with the scale next above it in the series.

Locality.—This, the only specimen I have seen of *Pleuropholis attenuatus*, was found by Mr. Bristow in the Middle Purbeck beds at Apsel Lane, north of Sutton Mandeville.

PLATE VII. Fig. 2.

PLEUROPHOLIS CRASSICAUDUS. Sp. Nov.

The specimen figured on the same plate with the above, No. 2, was found some years ago by Mr. W. Brodie in the bed known in the Durdlestone Bay section as the Insect Bed. It is now the property of the Rev. P. B. Brodie, of Rowington. It agrees with the genus *Pleuropholis* in the large size of the lateral scales, and in the extent and position of the anal fin; but differs from the species last described in the more massive proportions of the hinder part of the body, and in the characters of the caudal fin. The specimen measures one inch and three quarters from the nose to the base of the tail, and is three-tenths of an inch in depth. The latter measurement falls short of the actual dimensions of the fish, as the dorsal and ventral portions are wanting, and the larger scales alone remain. The head agrees for the most part with that of *Pleuropholis attenuatus*. The operculum is, perhaps, relatively larger, and the ganoid external layer thicker, characters which are repeated in the squamation. The scales comprised in the principal series are broader, thicker, and straighter, those in the vicinity of the tail are longer and more irregular in form. The position of the anal fin is discernible, but its characters are indistinct. The caudal fin has some strong fulcral scales on its lower margin, and appears to have been much stronger and less furcate than in the other species. A small fish discovered by the late Count Münster in the quarries of lithographic stone at Kelheim has a very close resemblance to this species, but the scales are more delicate and greatly more numerous. The tail is more like that organ in *Pleuropholis attenuatus*. A figure of this species is given on the Plate, No. 3. Professor Agassiz originally named it *Pholidophorus lavissimus*; he subsequently removed it to his new genus *Nothosomus*,* but it must now be considered a *Pleuropholis*.

Locality.—*Pleuropholis crassicaudus* is from the Insect bed of the Purbeck strata in Durdlestone Bay, No. 106 of Mr. Austen's table.†

PLATE VII. Fig. 4.

PLEUROPHOLIS LONGICAUDUS. Sp. Nov.

When engaged in examining materials for describing the several species of fossil fishes from the Purbeck strata published in the Eighth Decade of the Memoirs of the Geological Survey, I found

* Poiss. Foss., vol. 2, p. 288.

† Guide to the Geology of the Isle of Purbeck, by the Rev. J. H. Austen, page 17.

two specimens in the Museum in Jermyn Street, which, although very imperfect, gave evidence of another species of the genus *Pleuropholis*. I have recently received from the Rev. John Austen (whose abours in the Purbeck beds are well known to geologists) three additional specimens of a species of *Pleuropholis* apparently different from that indicated by the specimens in Jermyn Street. Of these, one, and that the most perfect, belongs to Mr. W. Brodie, of Swanage, and was found by him in the bed numbered 69 in Mr. Austen's table of the Purbeck strata; a less perfect specimen of a larger individual of the same species was furnished by Mr. Lister, of Langton Purbeck, and the third, a smaller one, is from Mr. Austen's private collection. As the specimens in the Jermyn Street Museum are not sufficiently perfect for detailed description, I may here briefly state that my reason for considering them specifically distinct from the subjects of this and the foregoing description rests upon the character of the large scales covering the flanks of the fish, which, in these specimens, are distinctly serrated on the posterior margin.

Mr. Brodie's specimen, of which a figure is given in the plate, measures three inches and three tenths from the nose to the extremity of the tail; the head and tail each measure seven tenths of an inch, and the greatest depth of the body is six tenths. These comparative dimensions attest the slender proportions of the fish, and, combined with the small size of the head and the large size of the tail, give evidence of its having been a swift and agile swimmer. The head is narrow, and somewhat pointed at the muzzle, the gape small, and with no traces of teeth discernible. In these respects, and in the relative proportions of its constituent members, it resembles the corresponding parts in the genus *Leptolepis*. The pectoral fins contain at least a dozen rays; the anterior one is armed with a border of long sharp spines; the succeeding three or four rays are very strong; all these have the transverse articulations rather distant. The remainder of the fin is composed of smaller bones, not very distinctly preserved. The ventral fins are small, and situated halfway between the snout and the extremity of the tail fin. The anal fin, commencing a little behind the ventral fins, extended almost to the insertion of the caudal fin. The number of rays constituting this organ cannot be ascertained from any of the specimens. The dorsal fin is small in this species, and situated immediately above the anal fin, a position for this fin very unusual in the members of the Lepidoid family, and very characteristic of the genus *Pleuropholis*. The base of the upper

lobe of the caudal fin is covered by an oblique prolongation of the scales of the tail. The upper margin of the fin is roofed with a series of elongated, imbricated scales, similar to those seen in the genus *Ophiopsis*, and common to most of the heterocerque fishes. The rays composing the fin are from twenty to thirty in number, and are long and powerful for the size of the fish. The pedicle of the tail is narrow, allowing great latitude of motion to the propelling organ. The general arrangement of the large scutiform scales investing the flanks of the fish corresponds with that described in the foregoing memoir; and is, in fact, a generic rather than a specific character. The scales on the back and belly are small and lozenge-shaped; these are connected, above and below, with the principal longitudinal series of high and narrow scutiform scales covering the parietes of the thorax and abdomen. Beyond the hinder part of the dorsal fin, the smaller scales encroach more and more on the principal series, and the latter diminish in altitude, until, in the proximity of the tail, all the scales are nearly uniform in size. The outlines of the scales in the principal series are waved in double curvatures, representing a series of parallel sigmoid lines of very graceful appearance, the curves becoming gradually less, until, in the caudal region, the scales are nearly rectilinear. All the scales are invested, on the outer surface, with a thick and shining coat of ganoine, without sculpture, and unbroken at the posterior margin. The under surfaces have broad, slightly elevated bands, occupying the median area of each scale (fig. 9). The connexion with the lozenge-shaped scales of the back and belly is provided for by a small process at the upper and a slight depression at the lower extremities of these bands.

Locality.—The specimen belonging to Mr. Lister is from near the bottom of the Downs vein of the Purbeck section, which, as I am informed by Mr. Austen, corresponds with the bed No. 69 in his tabular arrangement. Mr. Brodie's specimen is from the same region of the section, and Mr. Austen's is from a thin shale subordinate to bed 48 of his economic table, which corresponds with No. 69 of the Durdlestone Bay section.

PLEUROPHOLIS SERRATUS. Sp. Nov.

PLATE VII. Fig. 5—9.

I have recently ascertained that the specimens in the Museum of Practical Geology indicating another species of *Pleuropholis*, to which I alluded in the description of *Pleuropholis longicaudus*,

were derived from the Purbeck strata at Hartwell, near Aylesbury. Through the kindness of Dr. Lee, who has obtained a large number of specimens from the same locality, and who most liberally forwarded them to London for my inspection, I am enabled to complete the characters of a fifth species of this genus, which I have named *Pleuropholis serratus*. The specimens are for the most part so fragmentary that I have found it necessary to compile the specific characters from the examination of several individuals. The most perfect specimen (the only one indeed which conveys the form of the fish) is represented in the accompanying Plate, Fig. 5. The head and tail are both imperfect, and the body is a mere impression, the counterpart of which has, unfortunately, not been preserved. This *Pleuropholis* resembles the other members of the genus in the arrangement of the scales and the disposition of the natatory organs. It differs in its more massive proportions, and in having the posterior edges of the scales serrated. The body is short and deep, compared with the other species resembling in general outline the *Pholidophori*. The dorsal line is nearly straight, the ventral line rounded. The head as seen in the specimen figured No. 7 is small. The mouth opens upwards, and appears to be edentulous. In this character, and in the position of the orbits and form of the opercular flap, it is so like the head of a *Leptolepis*, that apart from other evidence it might be plausibly assigned to that genus. The pectoral fins seen in the same specimen are of small size, containing about ten rays. The ventral fins are deficient in all the specimens; the point of attachment, however, of these organs is seen, in Fig. 5 to have been nearly medial. The dorsal and anal fins, as in the other species of the genus, are opposite to each other, and very similar in form and size. The base of the tail is broad, and the scales do not extend so far on the upper lobe as in *Pleuropholis attenuatus* and *longicaudus*. The dorso-ventral series of scales are about forty in number; of these the first thirty are composed of large scutes, with a few small lozenge-shaped scales above and below. In the ten posterior rows, the scales are more uniform in size. The most appreciable distinctive character of this species is found in the serrated margin of the scales. This is more or less seen in all the specimens I have examined, but generally in the impression of the scales; the scales themselves being in so brittle a condition that they are never well preserved. The specimen I have selected to show the dermal characters is figured No. 6. on the plate. Figs. 8 and 9, show the outer surface of the scale *a*, and the inner surface of the scale *b*, enlarged.

Locality.—All the specimens are from the Purbeck strata of Hartwell, near Aylesbury.

EXPLANATION OF PLATE.

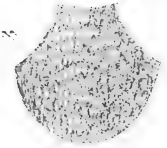
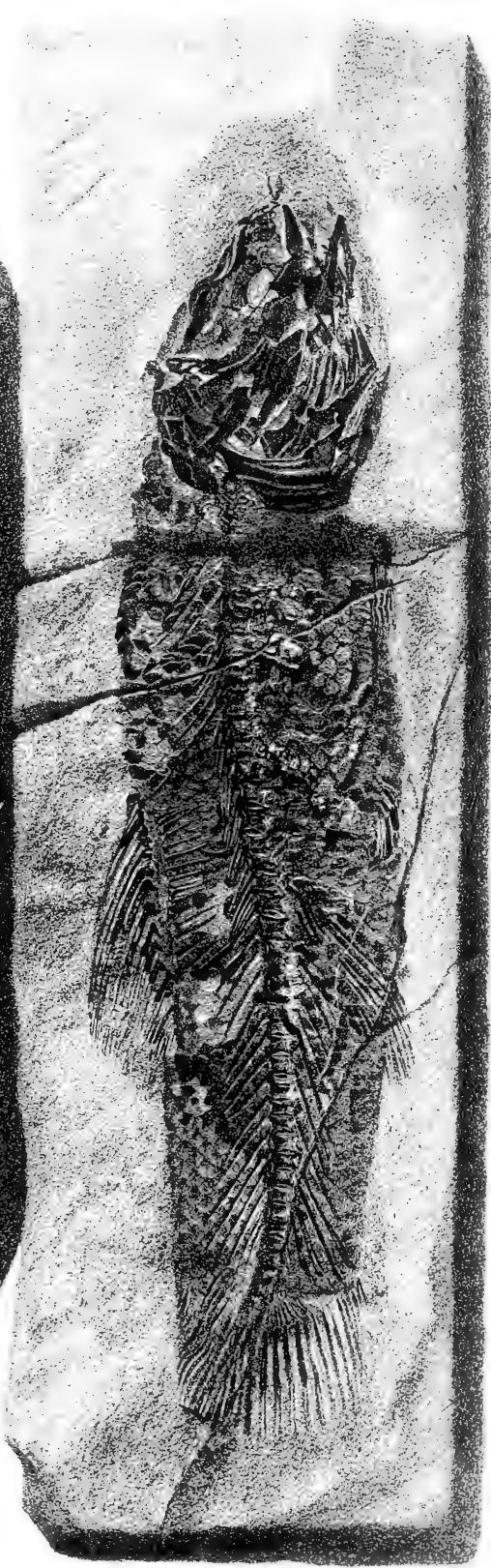
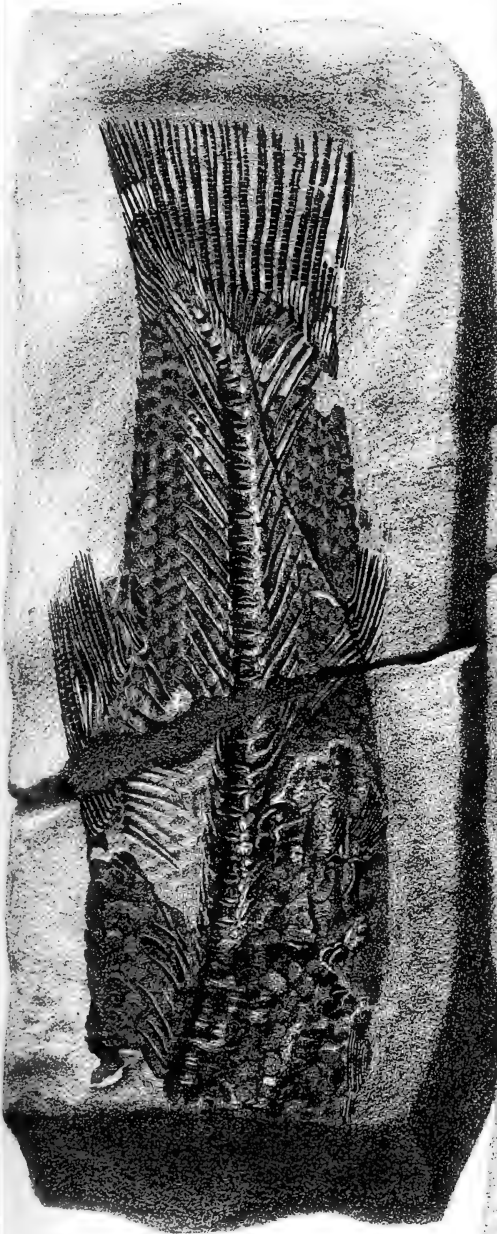
- Fig. 1. *Pleurophots attenuatus*, magnified.
Fig. 2. *P. crassicaudus*, size of nature.
Fig. 3. *P. levissimus*, size of nature.
Fig. 4. *P. longicaudus*, size of nature.
Fig. 5. *P. serratus*, size of nature.
Fig. 6. *P. serratus*, size of nature.
Fig. 7. *P. serratus*, size of nature.
Fig. 8. Scale *a*, magnified.
Fig. 9. Scale *b*, magnified.

P. DE M. GREY EGERTON.

February 1857.



PLATE I
FIGS. 1-3



MEGALURUS DAMONI. *Egerton*

2



BRITISH FOSSILS.

DECADE IX. PLATE VIII.

MEGALURUS DAMONI.

[Genus MEGALURUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 2nd Group, tail more or less rounded.) Caudal fin very large and rounded; dorsal fin opposed to the interspace between the ventral and anal fins; head large; jaws furnished with large conical teeth, intermixed with smaller ones. Vertebral centres ossified.]

Megalurus Damoni, SP. NOV.

This remarkable genus is placed by Professor Agassiz in a small group at the end of the Sauroid family, comprising in addition one fossil genus *Macrosemius*, and the recent genera *Lepidosteus* and *Polypterus*. The characters common to these four genera are the upward tendency of the termination of the vertebral column, and the rounded form of the caudal fin. In other respects they differ widely from each other. M. Pictet, laying greater stress upon the dermal peculiarities, has proposed a new order, "les ganoides cyclifères," for the reception of the fossil ganoids having rounded, imbricated scales. He divides this order into four families; the first comprises the recent *Amia*, and the fossil genera *Notæus* and *Cyclurus*; the second, "les Leptolepides," the genera *Leptolepis*, *Tharsis*, *Thrissops*, *Megalurus*, *Oligopleurus*, and *Coccolepis*; the third and fourth, "les Celacanthes" and "les Holoptychides," embrace the Cælacanthoid family of Agassiz. This is not the place to discuss at length the validity of the proposed new arrangement. The objections to it are manifold, and until some more satisfactory solution of the admitted incongruities of the old system is propounded the lesser evil will be to abide by the latter, rather than introduce new elements of discord of greater magnitude than those complained of. The ordinal titles proposed by M. Pictet involve a contradiction, for he associates together as "Ganoides cyclifères" several genera, some having and some devoid of the true ganoid character of the scales. Again, in his second order, "les Ganoides rhombifères," he includes *Pachycormus* and *Caturus*, genera in which the rhomboid form of scale becomes nearly obsolete, and the

curvilinear character begins to be appreciable. The reasons adduced in favour of the new scheme, from the teeth and other structural details, are still more untenable than those derived from the dermal characters; but the subject is too large to be further pursued in this article. The genus *Megalurus* is unquestionably a member of the Ganoid order as defined by Agassiz, the scales being invested with a coat of enamel, which, although thin, is unmistakable. I have ascertained that the scales of *Leptolepis* are similarly coated, a fact which is disputed by M. Pictet, and other continental ichthyologists. The large teeth of *Megalurus* designate its position as a genus of the Sauroid family. The structure of the vertebral column and its appendages, with the exception of the caudal portion, resembles that of the corresponding parts in *Caturus*. The distal extremity of the column and the caudal fin are most like those parts in *Macrosemius* and *Lepidosteus*, with some affinities to the Cælacanthoid family, more especially to the genus *Undina* of Count Münster. The genus *Oligopleurus* of Mr. Thiollière appears to be intermediate in character between *Caturus* and *Megalurus*, and affords an easy transition from the one to the other.

Description.—All the species of this genus hitherto described are from continental localities, their stratigraphical position being limited to the upper region of the Oolitic system. The subject of this article was discovered last year by Mr. Damon in the vicinity of Weymouth. It is intermediate in size between *Megalurus lepidotus* and *Megalurus elongatus* of Agassiz; it differs from the former in having the head comparatively shorter, the body more slender, and the scales more elongated; and from the latter in being a shorter and deeper fish. The specimen measures six inches from the nose to the extremity of the vertebral column, by one inch and a half in depth from the dorsal to the ventral fins. The body diminishes very slightly to the tail, the smallest diameter being one inch and one tenth. The head is one inch and seven-tenths in length, by one inch and two-tenths in depth. The scapulocoracoid bones are strong and smooth, having a thick prominent rib on the inner anterior margin. The vertebral column traverses the centre of the body. It is straight until it nearly reaches the tail, where it has an upward curvature. It contains about fifty biconcave vertebrae. The apophyses are short for the proximal two thirds of the column, but in the distal third they increase consecutively in length to the base of the caudal fin, and thence decrease towards the extremity of the column. The pectoral and ventral fins are small and indistinct. The first ray of the dorsal fin is imme-

diately over the attachment of the ventral fins. The middle of the fin is coincident with the centre of the dorsal line. It is supported upon seventeen strong interneural spines, and contains a like number of rays. These are entire for some distance from the base; they then bifurcate, and are transversely jointed at small intervals. The anal fin is situated nearer to the ventrals than to the lower lobe of the caudal fin. It is attached to eight ossicles, and is composed of as many rays, agreeing in all respects with those of the dorsal fin, except in being shorter and more slender. There are traces of border scales on the first rays of both. The caudal fin is broad and rounded posteriorly. In form it resembles the tail of the recent *Lepidosteus*. A few fin rays, constituting the upper lobe, spring from the neurapophyses of the sixth, seventh, and eighth vertebræ, reckoning from the caudal extremity of the column. These are single, without bifurcations or transverse joints; the remainder, about twenty in number, are supported by the flattened extremities of the elongated hæmapophyses. They are coarse, with three or four bifurcations and frequent joints. The fin is completed below by a few single rays springing from the hæmapophysis of the fifteenth vertebra. This is the longest of these processes; those behind it decrease in gradation to the extremity of the column. The scales are large, and rounded posteriorly; they differ from the scales of *Megalurus lepidotus* in having the longitudinal diameter greater than the transverse. They are thick, and of a coarse texture, and are covered exteriorly with a thin coat of enamel, ornamented with fine concentric rings. They have no rib or articulating process on the inner surface. In this respect, and in their imbricated arrangement, they very much resemble the scales of a *Cealacanthus*. This very interesting addition to our list of British fossil fishes I have designated by the specific name of *Megalurus Damoni*.

Locality.—Found by Mr. Damon in the Purbeck strata at Bincombe, about three miles north of Weymouth.

EXPLANATION OF PLATE.

Fig. 1. *Megalurus Damoni*, size of nature.

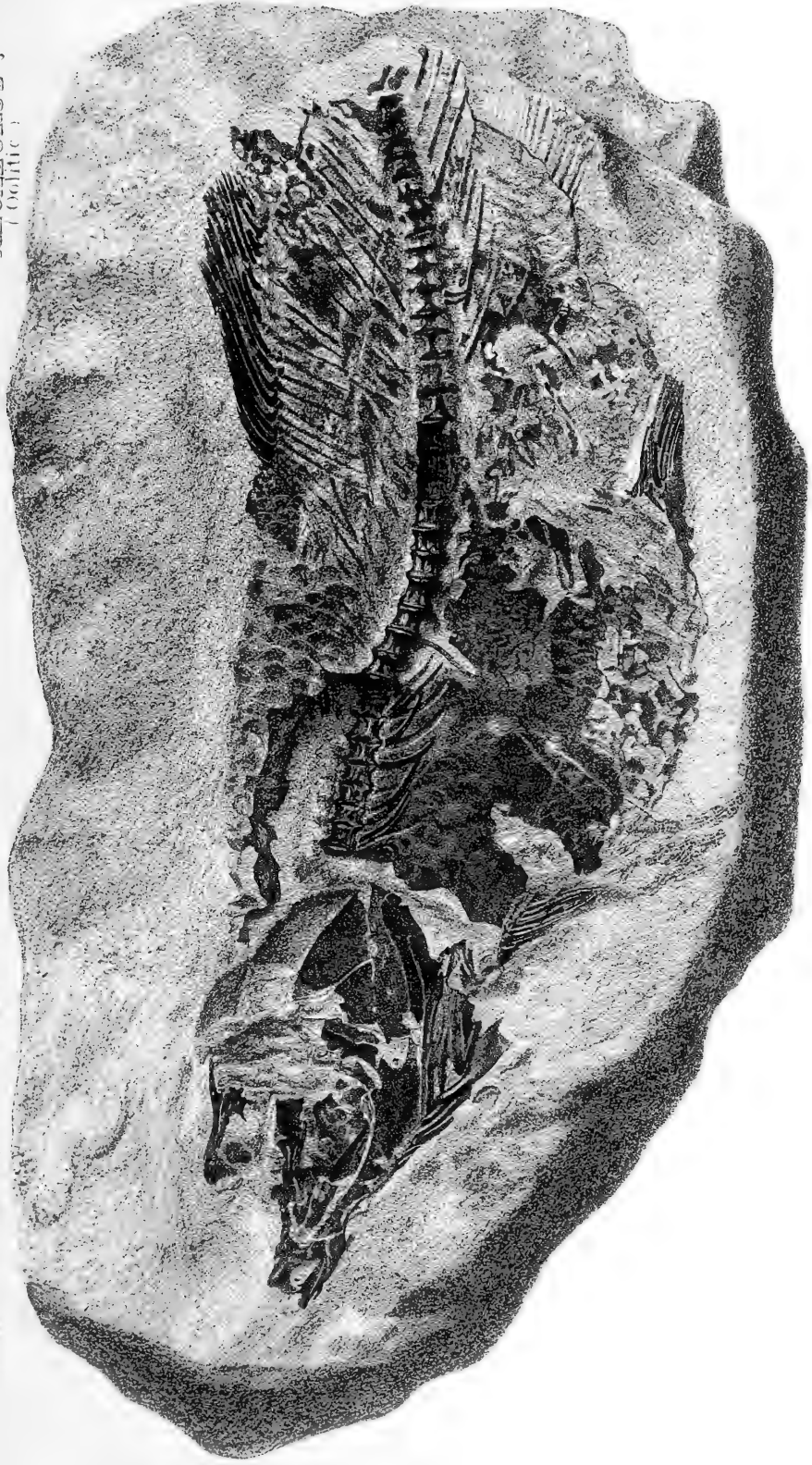
Fig. 2. Counterpart of do., size of nature.

Fig. 3. Scale, magnified.

P. DE M. GREY EGERTON.

February 1857







BRITISH FOSSILS.

DECADE IX. PLATE IX.

MEGALURUS AUSTENI.

[Genus MEGALURUS. AGASSIZ. Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 2nd Group; tail more or less rounded.) Caudal fin very large and rounded; dorsal fin opposed to the interspace between the ventral and anal fins; head large; jaws furnished with large conical teeth, intermixed with smaller ones; vertebral centres ossified.]

Megalurus Austeni. SP. NOV.

Description.—The discovery of the very perfect specimen described in the preceding article has furnished the clue to the true nature of a group of ichthyolites not uncommonly occurring in the quarries of Purbeck stone at Swanage, but for the most part in a very fragmentary condition. Many of these specimens have come under my notice from the collections of Mr. Austen and others, who have turned their attention to the Purbeck fossils; but I have hitherto failed to recognize them as belonging to the rare genus *Megalurus* of Agassiz. The parts most commonly preserved are the vertebral column and some of its spinous appendages, and such specimens have generally been considered as belonging to the *Lepidotus minor*, so common in the Swanage quarries. Last year I obtained a specimen, more perfect than any I had before seen, of this fish, but as the tail, so characteristic of the genus was deficient, I passed it over without a detailed examination, in the hopes that more satisfactory evidence of its generic affinity might be brought to light. While examining the specimen described in the last article, and comparing it with other specimens, I became aware of the affinity between it and the Swanage specimens, a result which subsequent investigation proved to be correct as to general relationship, the species, however, being distinct. The portion of the fish preserved in the specimen comprises about two-thirds of the entire length, the hinder third being deficient. The pectoral, ventral, and dorsal fins are seen in situ, but the anal fin is wanting. The fish, when entire, would probably measure ten or eleven inches in

length. The greatest depth is two inches and a half. The head is proportionately smaller than in the other species of *Megalurus*, and the posterior edge of the opercular flap more angular. The dorsal line is nearly straight, while the abdominal line has a considerable downward curvature. These lines are nearly parallel in *Megalurus Damoni*, and in *Megalurus lepidotus* the dorsal line is more curved than the abdominal line. Thirty-five vertebræ are preserved, of strong osseous texture. The length of each is rather greater than the diameter. The peripheral pits are deep and strongly marked, but the size of the intervertebral cavities cannot be ascertained. The processes of the anterior vertebræ are short, thick, and curved, those of the posterior part of the column straight, long, and slender. The scapulocoracoid arch appears to have been slight, and the pectoral fins of moderate size. The component rays are subdivided transversely into a great number of ossicles, a structure which must have given great pliability to the fin. The ventral fins are small, but strengthened by a thick anterior ray to each fin, having considerable curvature at its pelvic extremity. The dorsal fin is situated over the ventral fins, and extends as far backwards as the insertion of the anal fin. The three or four anterior rays are short, strong, and pointed, the succeeding rays are long, dichotomous, and articulated transversely at short intervals. The number of rays composing the fin was not less than seventeen, and these are supported on a like number of interapophyseal ossicles deeply inserted in the integumentary tissues. The position of the anal fin is seen by a slight impression of the anterior rays in the matrix of the specimen, but an unfortunate fracture has removed the fin itself. The scales more nearly resemble those of *Megalurus lepidotus* than those of *Megalurus Damoni*; they are, however, too imperfect to be accurately examined. I have named this species *Megalurus Austeni*, in recognition of the labours of the Rev. John Austen in working out the stratigraphical details of the Purbeck beds.

Locality.—The specimen figured and described was found in a quarry of Purbeck stone in the neighbourhood of Swanage, and is now in my possession.

DESCRIPTION OF PLATE 9.

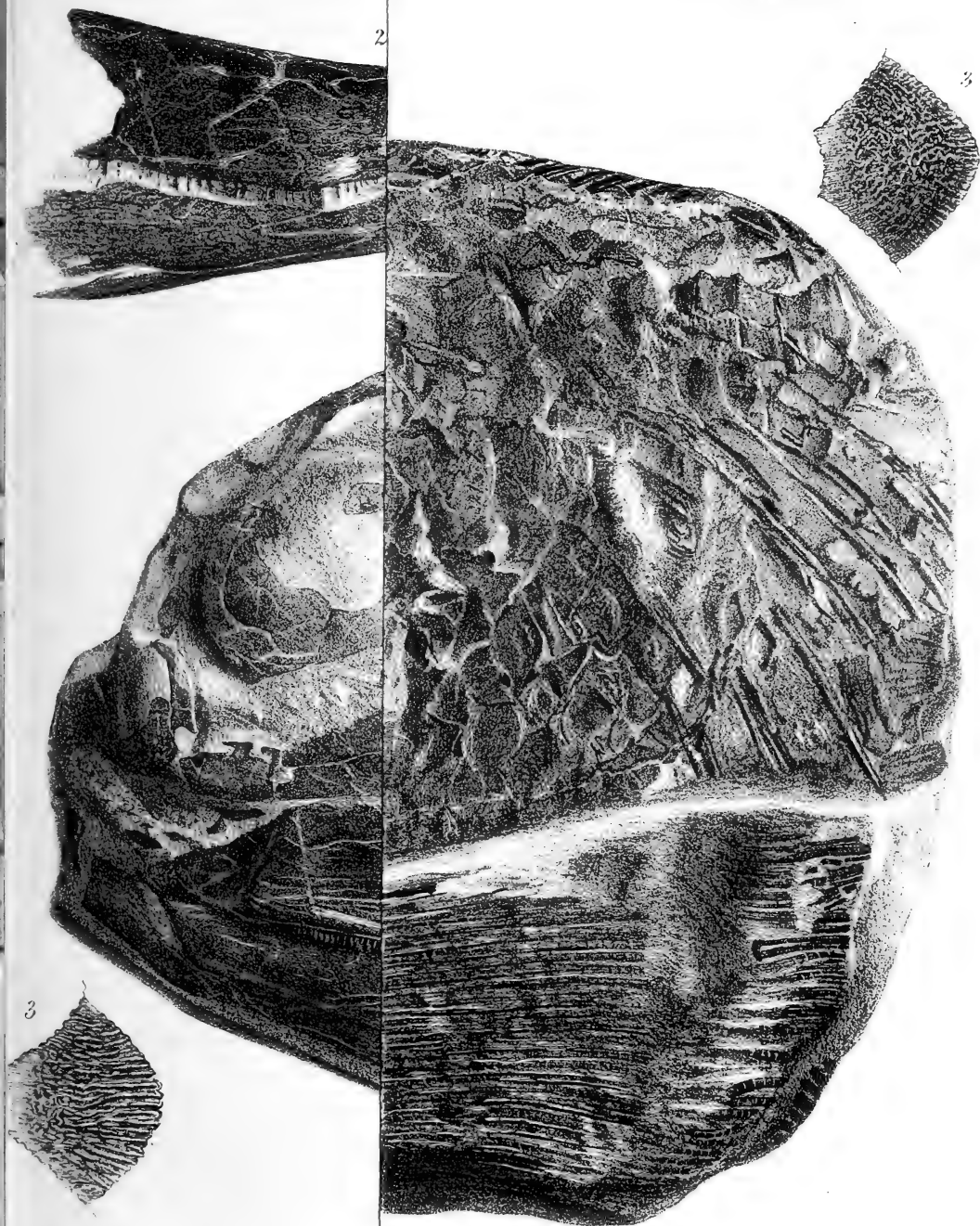
Fig. 1. *Megalurus Austeni*, size of nature.

P. DE M. GREY EGERTON.

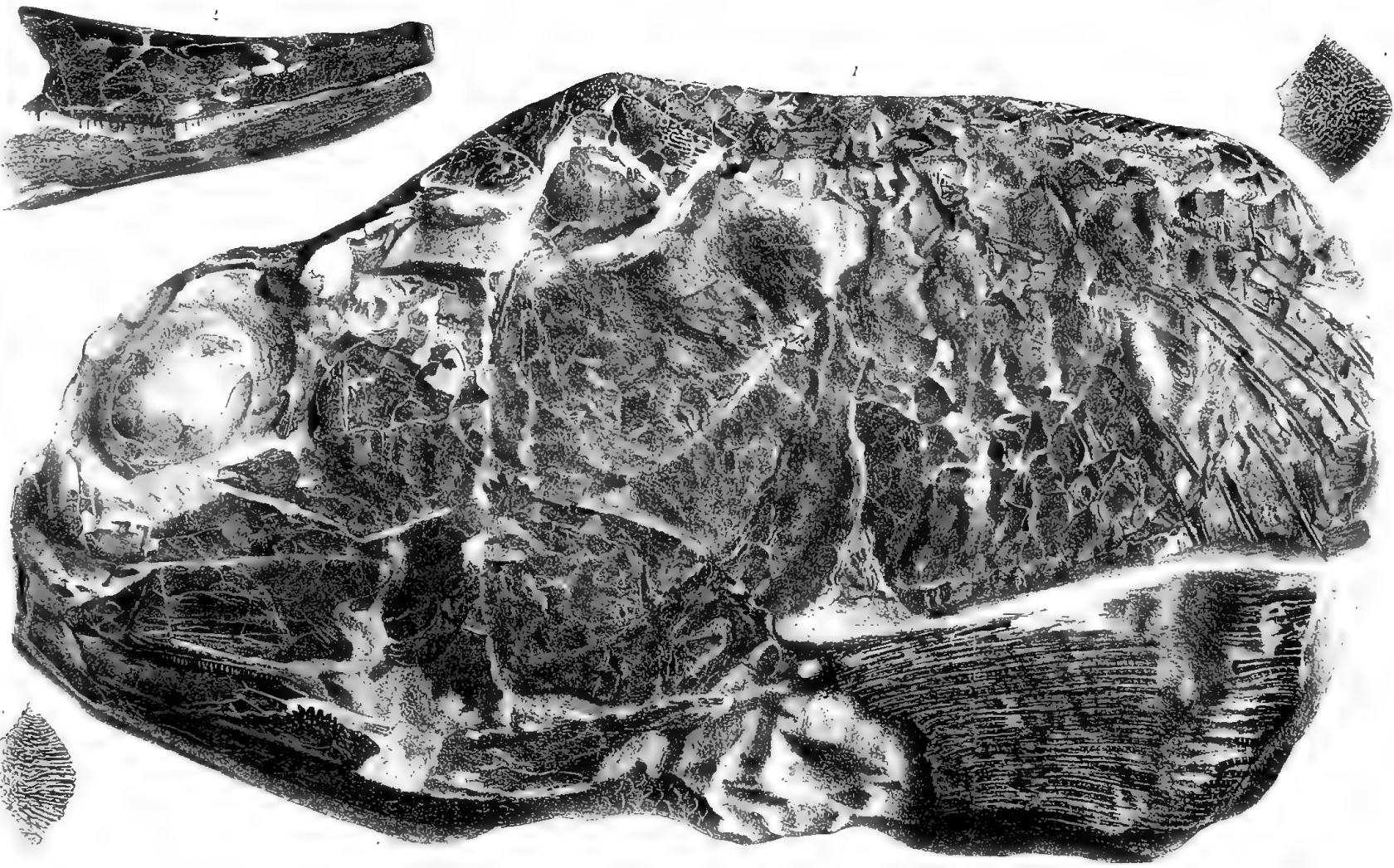
April 20, 1857.

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3



3



MACROPOMA EGERTONI *Agassiz*.



BRITISH FOSSILS.

DECADE IX. PLATE X.

MACROPOMA EGERTONI.

[Genus MACROPOMA. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Cælacanthi.) Caudal fin very large, rounded. Two dorsal fins, one over the interspace between the pectoral and ventral fins, the other opposed to the interspace between the ventral and anal fins. The rays armed with marginal spines. Scales enamelled, imbricated, rounded posteriorly, and tuberculate. Teeth large and conical, intermixed with smaller ones. Vomer and palatines dentigerous.]

Macropoma Egertoni. AGASSIZ. Poiss. Foss. vol. 2, part 2, page 186.

At the time when Professor Agassiz was engaged upon his great work on the Fossil Fishes, the materials crowded in upon him in such abundance that he found it impossible to comprise them all in one publication, with any prospect of completing it in reasonable time. He therefore determined to finish his original work in five volumes, and to postpone the descriptions of those species he could not incorporate, to form a series of supplementary monographs. He was only able to issue one of these, that on the fishes of the Old Red Sandstone, before his engagements in the United States put a stop to his ichthyological labours on this side the Atlantic. As there seems to be little chance now of his resuming the subject, it appears to me desirable that some of the most characteristic genera and species which were named by him, but not described, should no longer remain in our catalogues undefined. I have therefore selected a few of the most striking forms for description in this Decade. The genus *Macropoma* is one of the most singular in the whole range of fossil ichthyology. We owe its discovery to the indefatigable zeal and scientific skill of the late Dr. Mantell, who described the only species then known under the name of *Amia Lewesiana*. Professor Agassiz subsequently determined it could not be considered as belonging to that genus, but that it constituted a new generic type, to which he gave the name now adopted. The specific name given by Dr. Mantell ought to have been continued, but a departure from the rigid rule of scientific nomenclature was

justifiable in this case for the purpose of perpetuating the name of the talented discoverer of *Macropoma Mantelli*. The remains of this fish are most numerous in the chalk formations of the south of England, and are all referable to one and the same species. The subject of this article constitutes a second species of the genus found in the Gault at Speeton, in Yorkshire. The specimen which is in my possession is unique, and Professor Agassiz did me the honour of naming it after me.

Description.—The reasons assigned by Professor Agassiz for considering this a distinct species in the short allusion he makes to it in the “Poissons Fossiles,” are, “the more uniform character of the scales, and differences in the form of the head.” These and other specific peculiarities will be treated of in the sequel. The specimen exhibits only the anterior half of the fish; comprising the head, the pectoral fin, and the first few rays of the dorsal fin. It evidences a fish of the largest dimensions attained by the Mantellian species. The head from the snout to the posterior edge of the operculum measures seven inches; the depth at the occiput is five inches and a half, and the breadth across the frontal bones three inches. The inclination of the profile line of the head is very steep from the occiput to the orbit, far more so than in the allied species; the orbit is situated in a more advanced position, and the facial line thence to the snout falls much more rapidly. The opercular apparatus covers a far larger area, and the breadth of the cranium is comparatively greater. The orbit in this species is large, and a portion of the capsule of the eye is preserved. The frontal bones are wide, coarse in texture, and bear a few scattered granules on their exterior surface. The borders of the upper jaw are formed by the superior maxillary bones, which are very broad; they are beset with very numerous sharp pointed teeth, closely arranged and of uniform size. The lower jaws are also very broad, and the space between the rami is closed by a single glossohyal plate, as in *Lophiostomus*, *Arapaima*, and *Amia*. The lines of demarcation between the opercular bones are not discernible, but the entire apparatus is considerably larger than the corresponding parts of *Macropoma Mantelli*. The pectoral fin is of large dimensions. This organ is not mentioned in the description of *Macropoma Mantelli*, nor is it well seen in any of the specimens of that species I have examined. It may or may not, therefore, be a distinctive and specific character. The fin is by no means perfect in my specimen, but it measures four inches and a half in length, by two inches in breadth. The rays are very numerous, and differ from those of the dorsal fin by being dichotom-

ized, transversely jointed, and devoid of spines. The base only of the dorsal fin is visible; it is situated three inches from the occiput. The scales are smaller and more uniform in size than those of the other species; they are rounded posteriorly, and are higher than long. The surface ornament is very different; instead of the distinct tubercles so characteristic of that species, it is composed of minute granules united into longitudinal rows, with only a few small tubercles, interspersed occasionally, on some of the larger scales. The characters above detailed fully warrant the specific distinction of this from the species described by Dr. Mantell.

Locality.—Found in the Gault strata at Speeton, in Yorkshire.

DESCRIPTION OF PLATE.

Fig. 1. *Macropoma Egertoni*, size of nature.

Fig. 2. Maxillary bones of the opposite side.

Figs. 3. Scales, magnified.

P. DE M. GREY EGERTON.

February 1857.

Note.—Since the above description was written, I have received from Mr. Beckles a specimen of a *Macropoma* found in the quarries of Purbeck stone near Swanage. The specimen is not sufficiently perfect to determine the species; it seems to be a shorter and deeper fish than *Macropoma Mantelli*. It is interesting to know that the genus was in existence previous to the deposition of the cretaceous system.

P. DE M. GREY EGERTON.

April 20th, 1857.

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| | | - - | 2 |
| PACHYCORMUS : | | | |
| Latipennis - - - - | IX. | 3 | 1 |
| PALÆONISCUS : | | | |
| Egertoni - - - - | VI. | 2 | 1 |
| Monensis - - - - | VI. | 2 | 2 |
| PHOLIDOPHORUS : | | | |
| Crenulatus - - - - | VI. | 5 | 1 |
| Granulatus - - - - | VIII. | 4 | 1 |
| Higginsii - - - - | VIII. | 7 | 1 |
| Nitidus - - - - | VIII. | 7 | 3 |
| Pachysomus - - - - | VI. | 4 | 1 |
| PLEUROPHOLIS : | | | |
| Attenuatus - - - - | IX. | 7 | 1 |
| Crassicaudus - - - - | IX. | 7 | 3 |
| Lævissimus - - - - | IX. | 7 | 3 |
| Longicaudus - - - - | IX. | 7 | 3 |
| Serratus - - - - | IX. | 7 | 5 |
| PTYCHOLEPIS : | | | |
| Curtus - - - - | VIII. and Sup- plement | 8 | 1 |
| | | - - | 1 |
| Minor - - - - | VI. | 7 | 1 |
| PYCNODUS : | | | |
| Liassicus - - - - | VIII. and Sup- plement | 10 | 1 |
| | | - - | 3 |
| THRISSENOTUS : | | | |
| Colei - - - - | IX. | 2 | 1 |

MEMOIRS
OF THE
GEOLOGICAL SURVEY
OF
THE UNITED KINGDOM.

Figures and Descriptions

ILLUSTRATIVE OF
BRITISH ORGANIC REMAINS.

—
DECADE X.

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# BRITISH FOSSILS.

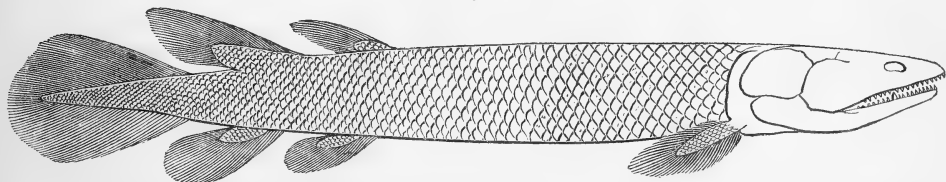
## DECADE THE TENTH.

PRELIMINARY ESSAY upon the SYSTEMATIC ARRANGEMENT of the FISHES of the DEVONIAN EPOCH, by THOS. H. HUXLEY, F.R.S., Professor of Natural History, Government School of Mines.

THE endeavour to determine the systematic position of *Glyptolæmus*, a genus of Devonian fishes, first described and figured in Dr. Anderson's interesting work upon "Dura Den,"\* and more fully discussed and illustrated in the course of the present Decade, has gradually led me to reconsider the whole question of the classification of the fishes of this epoch and, eventually, to arrive at results which seem to necessitate an important modification of the received arrangement of the great order of Ganoidei.

I propose, in the course of the pages of this preliminary essay, to take the reader through the various steps of the argument which terminates in this conclusion; and, commencing with a brief enumeration of the most important characters of *Glyptolæmus*, I shall proceed to the discussion of the peculiarities of other genera, more or less nearly allied to it, with the view of demonstrating, finally, that *Glyptolæmus* is a tolerably typical member of a large and well defined family of Ganoids, which abounded in the Devonian epoch, but whose members have been less and less numerous in more modern formations, until, at present, its sole representative is the African *Polypterus*.

FIG. 1.



Restoration of *Glyptolæmus*.

*Glyptolæmus Kinnairdi* (fig. 1, and Plates I. and II.), the only known species of its genus, is a fish with an elongated body, a depressed head,

\* Dura Den; a Monograph of the Yellow Sandstone, and its remarkable Fossil Remains. 1859.

and a conically tapering caudal extremity. The orbits are situated forwards, while the gape extends far back. The frontal bones (fig. 2) are distinct from one another and from the parietals, which last are not shorter than the frontals, and, though in contact throughout the whole length of their inner margins, are perfectly distinct from one another. Three bones, or scales (for they seem to partake as much of the nature of the latter as of the former), a median and two lateral, roof in the occipital region. The middle of the jugular region, or that comprised between the two rami of the mandible upon the under surface of the cranium, is occupied by two large, triangular, squamiform, bones—the *principal jugular plates* ( $J^1$ ); while the interval left between them and the mandibular rami, on each side, is taken up by a series of smaller, quadrate plates, which increase in size from before backwards—the *lateral jugular plates* ( $J^2$ ). There is no rhomboidal *median jugular plate* interposed between the anterior part of the inner edges of the principal jugular plates. The teeth are of two kinds; smaller, set in a close series along the edges of the jaws; and larger, placed at intervals along the palate, and perhaps along the inner side of the mandible. The larger teeth have grooved bases, and appear to be composed of dendrodentine.\*

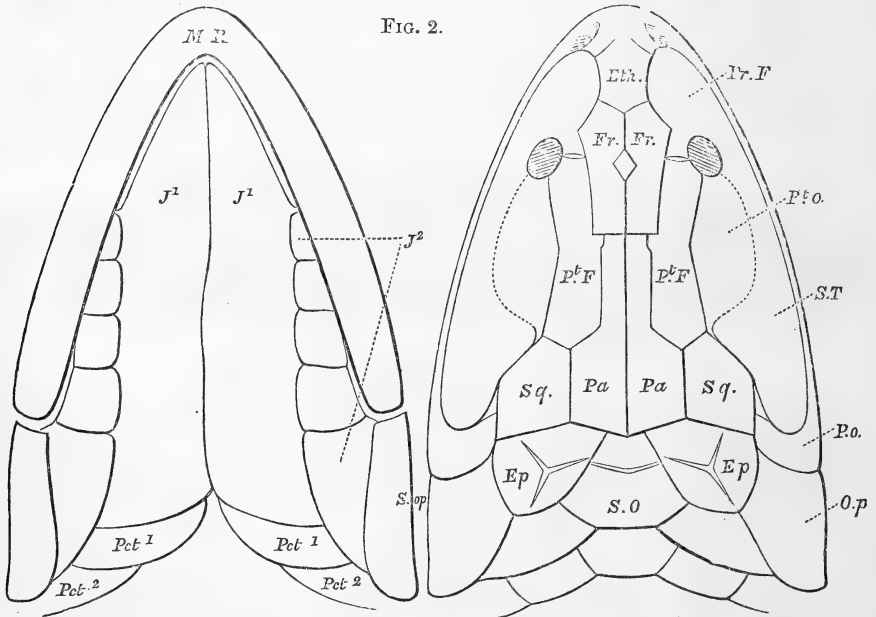


Diagram of the Head of *Glyptotamus*.—For an explanation of the letters, see p. 40.

\* Prof. Pander applies the term "Dendrodonts" to those fishes the pulp cavities of whose teeth appear branched, in consequence of the folding of their walls; and such folded dentine may be conveniently termed "dendrodentine."

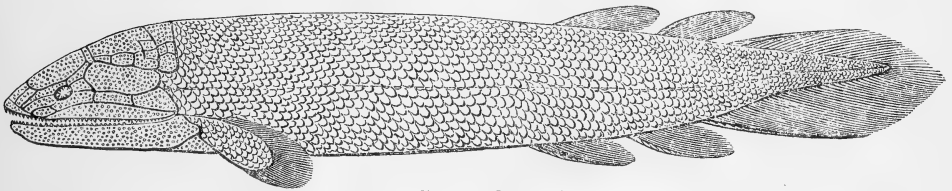
The pectoral arch is covered by two triangular, sculptured, osseous plates (Pct<sup>1</sup>, Pct<sup>2</sup>), which meet in the middle line below and are superficial to the so-called coracoids. The paired, or pectoral and ventral, fins are lobate; that is, the fin has a central axis, or stem, covered with scales. There are two dorsal fins, placed in the posterior half of the body. The ventral fins are situated under the first dorsal, and are succeeded by a single anal. The caudal fin, whose contour is rhomboidal, is divided into two equal lobes by the prolonged conical termination of the body; in other words, the fish is diphycercal, or truly homocercal.\*

Every ichthyologist will admit the singularity of this combination of characters, but a careful analysis of the structural peculiarities presented by other fossil fishes of the same age, will show, that, so far from isolating *Glyptolemus*, they closely unite it with several other genera.

That genus which appears to me to approach it most closely is the *Gyroptychius* of M'Coy, whose structure has received admirable elucidation from Professor Pander in his beautiful monograph "Ueber die Saurodipteren, Dendrodonten, Glyptolepiden und Cheirolepiden des Devonischen Systems" (1860), to which I may refer those who desire to obtain a more particular acquaintance with the details of its organization.

Here I must content myself with reproducing in a reduced woodcut (fig. 3) Professor Pander's restoration of the fish, which may

FIG. 3.

Restoration of *Gyroptychius* (after Pander).

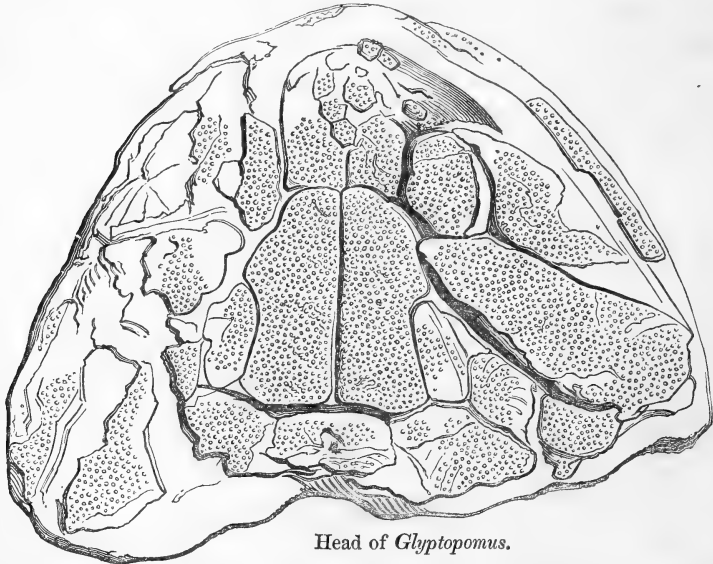
be compared with the restored woodcut of *Glyptolemus* (fig. 1), and with the Plates, and with stating that the head, the body, and the fins of *Gyroptychius* might be described in the terms which have just been applied to *Glyptolemus*. Pander, however, makes no

\* I have endeavoured to show elsewhere (Quarterly Journal of Microscopical Science, Oct. 1858) that the so-called "homocercal" *Teleostei* of the present epoch are in reality excessively heterocercal; but the word "homocercal" is now so generally understood to signify a tail like that of most existing *Teleostei*, that I prefer to employ Prof. M'Coy's term "diphycercal" for truly homocercal tails. See, on this point, Kölliker, "Ueber das Ende der Wirbelsäule der Ganoiden, 1860," and Van Beneden, "Sur le Développement de la Queue des Poissons Plagiostomes," Bull. de l'Acad. Royale Belgique, 1861.

mention of lateral jugular plates; the scales, which are as often oval as rhomboidal, are sculptured in a very different manner from those of *Glyptolæmus*, and, according to Pander, the anterior edges of the median fins are provided with fulcra.

*Glyptopomus* (Agassiz) is another genus whose close alliance with *Glyptolæmus* is evidenced by the structure of its skull, of which there is a fine specimen in the British Museum. It is very depressed and has two distinct frontal bones, separated anteriorly by a small rhomboidal plate; there are two long and distinct parietals, and three bones, one median and two lateral, behind these, covering the occiput. The orbits are situated far forward, the gape is greatly elongated, there are two principal jugular plates, and the pectoral arch is as in *Glyptolæmus*. A fine specimen in the Museum of Practical Geology shows that some of the teeth, at any rate, were of large size, and longitudinally grooved at their bases.

FIG. 4.

Head of *Glyptopomus*.

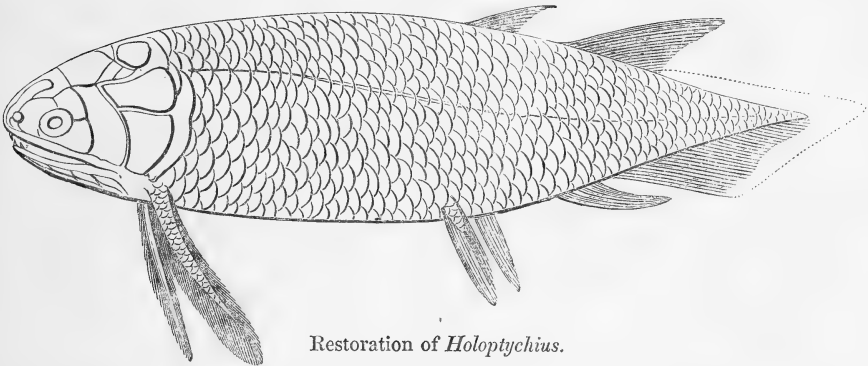
Only three specimens of *Glyptopomus* are at present known, and no one of these exhibits either the paired or the median fins; but the close correspondence of the cranial structure of this genus with that exhibited by *Glyptolæmus*, leaves no doubt on my mind that, when discovered, the fins will be found to be similar, in all essential respects, to those of the latter genus (*see note, p. 46*). The sharply rhomboidal scales are thicker in proportion than those of any other Devonian fish, and are pitted upon their surfaces like the scutes of the *Crocödilia*.



As has been seen, the angles of the scales of *Gyroptychius* are apt to become rounded off, so as to present a transition from the rhomboid to the cycloid contour, and, hence, it is less surprising than it seems at first sight, to find fishes with eminently cycloid scales, so similar, in all the essential features of their organization, to *Glyptolæmus*, *Gyroptychius*, and *Glyptopomus*, as imperatively to demand a place near them in any natural arrangement.

*Holoptychius* (Agassiz), for example, has a depressed head (though deeper than that of *Glyptolæmus*), and a conically tapering caudal extremity; the orbits are situated far forwards and the gape extends far back. The frontal bones are distinct from one another, and from the parietals, which last are large and co-adapted, though quite distinct; the occiput is covered in by three bones, a median and two lateral; there are two principal and a number of lateral jugular plates, and there is no rhomboidal median jugular plate interposed between the principal jugulars. Some of the teeth are larger than the others, and longitudinally striated at their bases. The paired fins are very acutely lobate, and there are two dorsal fins placed in the posterior half of the body. The ventral fins are situated under the first dorsal, and are succeeded by a single anal.

FIG. 5.

Restoration of *Holoptychius*.

Thus far, the reader who compares this description with that of *Glyptolæmus* already given, will find the two essentially identical. But the tail of *Holoptychius* differs from that of *Glyptolæmus*, in that it is little more than semi-rhomboidal, the upper moiety being far less developed than the lower,\* and the scales are,

\* In my restoration of *Holoptychius* (Dr. Anderson's "Dura Den," p. 69) I have represented the fish with a diphyccercal tail; but I am now prepared to admit that the evidence on which I rested this conclusion was not trustworthy, and that Sir Philip Egerton's view of the case is in all probability correct. However, I must say, that I have never yet seen a *Holoptychius* with its caudal extremity in a perfectly satisfactory state of preservation.

in form and sculpture, widely different from those of the latter genus.

That *Platygnathus* (Agassiz), if we restrict the name to the fish whose caudal extremity is figured by Agassiz ("Vieux Grès Rouge," Tab. 25), is very closely allied to *Holoptychius* cannot be doubted; indeed, the only serious question regarding it, in the absence of further materials for its reconstruction, seems to be, whether it should really form a separate genus; so that I may pass on to another generic type, *Glyptolepis* (Agassiz).

This genus is briefly mentioned in the "Recherches sur les Poissons Fossiles," ii. p. 179, but Agassiz first described and figured species of it in the "Monographie des Poissons du Vieux Grès Rouge," p. 62, where *Glyptolepis* heads the family of the "Célocanthes," and is said to comprise fishes of moderate size, with pyriform bodies, and with heads which are small, short, flattened, and have an almost semi-circular contour. The rami of the mandible are stated to be beset throughout their length with a single series of small, equal, conical teeth, which seem to approach those of *Dendrodus* and *Holoptychius* in structure, and to have a dendritic pulp cavity surrounded by folded dentinal walls. *Glyptolepis microlepidotus*, however, is said (p. 65) to possess large teeth alternating with small ones in the lower jaw. The upper jaw projected beyond the lower a little, and had similar teeth. The throat was provided, as "in all ancient "Coelacanth and in *Polypterus*, with two mobile triangular plates, "which replace the branchiostegal rays."

The scales were delicate, rounded, and so much imbricated that the anterior one sometimes covered more than half of its successor. Their upper faces were entirely smooth, and covered with a delicate layer of enamel, which, apart from some concentric lines of growth, exhibited no ornamentation. Their inferior faces were also smooth, and formed by a very delicate layer of bone. The mass of the scale was formed by an osseous and spongy substance, adorned with fine rays, which radiated from the centre of the scale. These rays were intersected by concentric and circular lines, so that a scale, whose smooth layer is worn away, presents a number of small elongated cells, disposed in circular series, almost like the seats of an amphitheatre.

In the "Additions et Corrections," (l. c., p. 140), Agassiz adds a description of the scales of *Glyptolepis elegans*, which supplies an important correction to that just given. Referring to Tab. 21 a, he says, "The figure 2 a represents a scale of its natural size, and "fig. 2 the same magnified. *The folds of the surface which constitute the ornaments of the visible portion of the scale are more*

“distant than in the foregoing species.” Thus it is admitted that *Glyptolepis* has not smooth, but sculptured scales, as, indeed, the name of the genus implies.

Agassiz enumerates a caudal, two dorsal, and two anal fins, but states that the existence of pectorals is doubtful, and that, in any case, they must have been small and inconsiderable. The ventral fins, on the other hand, are said to possess a singular structure, “which is also to be found in *Megalichthys*.” A series of plates extends as a pointed band along the belly, and, becoming free at its posterior extremity, carries numerous rays on both sides, and thus forms a ventral fin, which, from the manner in which its rays are disposed, is very like an eel’s tail. (Tab. 21, fig. 2.) I have examined the specimen here referred to, which forms a part of Sir Philip Egerton’s collection, and, with Professor Pander, I feel satisfied that the fin in question is the very long, acutely lobate, pectoral, bent back in such a manner, that the proximal half of its posterior edge is covered by the lower margin of the abdomen of the fish.

Professor Agassiz goes on to say that the two dorsals are opposed to the two anals, and are situated so far back that the caudal directly follows them. They are so close together that the last ray of the first touches the first ray of the second. The second dorsal and anal are higher than the first, and the caudal is large, heterocercal, and triangular, appearing to be almost vertically truncated; its superior division bears numerous little fulcra.

Hugh Miller (“Old Red Sandstone,” 1841,) made some important improvements upon Agassiz’s description and definition of *Glyptolepis*. He pointed out with great justice (and figured a specimen demonstrating the fact), that there is only one anal; the second, or posterior of Agassiz, the ventrals having been mistaken for an anterior anal, and he describes and gives a sketch of the sculptured outer surface of the scales.

Professor Pander, in the Monograph already cited, has carried the work of rectification still further, though even he ventures upon no restoration of *Glyptolepis*, seeming to be unacquainted with the figure of the body of the fish, from a specimen more complete than any of those of Agassiz, or of his own, given by Hugh Miller.

In addition to what was already known, he states that the principal jugular plates are separated, anteriorly, by a small rhomboidal one, and he makes the observation that “these plates, which among living fishes occur double only in *Polypterus*, and are among fossils known only in *Osteolepis*, *Diplopterus*, *Megalichthys*, and *Gyroptichius*, lead to the supposition that the composition of the cranial and facial bones will differ in no important respect from what is

“ found in them ;” and this supposition is, he states, confirmed by the similarity of the upper and lower jaws and teeth. Behind the jugular plates, and applied to their hinder edges, Professor Pander finds two others, which meet in the middle line, and resemble those which lie upon the under surface of the pectoral arch in *Polypterus*.

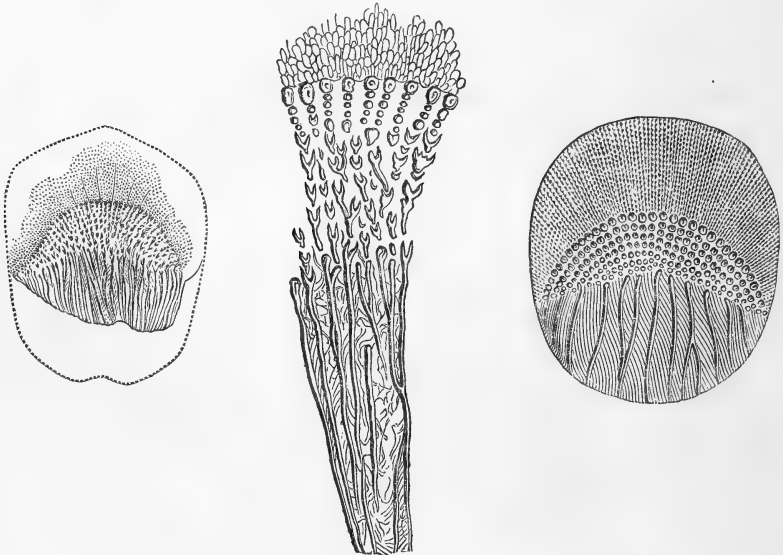
The scales are, in general, rounded, sometimes circular, sometimes oval, sometimes more or less quadrate, by reason of the less rounding off of their angles. They overlap in different degrees, and their external sculpture is different in different parts of the body, whence arises such an amount of unlikeness, that different species might readily be founded on scales from different regions.

The sculptured surface presents two divisions, one, more anterior, exhibits small tubercles with projecting points, which are convex posteriorly, concave anteriorly, and are disposed in regular series converging towards a central point, which, however, they do not reach.

The posterior segment is covered with wavy longitudinal costæ, which gradually diminish in thickness from the anterior towards the posterior edge.

Professor Pander gives a figure of this peculiar sculpture, a woodcut copy of which I subjoin, and side by side with it a careful drawing of the sculpture of the scale of a *Glyptolepis* from Wick, in an even better state of preservation.

FIG. 6 :—The two left hand figures represent the scale from Wick of the natural size and its sculpture magnified ; the right hand figure is copied from Pander's Monograph.

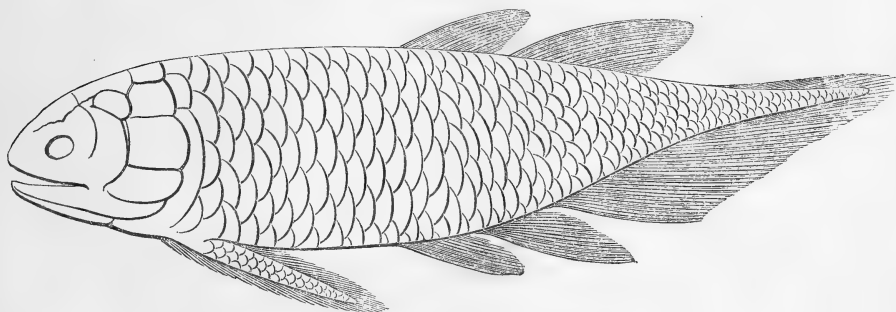


There can be no doubt that the scales of *Glyptolepis* possess the ornamentation here represented. Not only does Professor Pander positively state that the scale figured by him was worked out from a Lethen Bar nodule, and formed part of the unquestionable *Glyptolepis* represented in his Plate 7, fig. 4<sup>1</sup>; but the specimen of *Glyptolepis leptopterus* represented by Agassiz in the "Vieux Grès Rouge," Tab. 21, fig. 2, and now in Sir Philip Egerton's collection, has obviously sculptured scales and cranial bones. And I find that by scraping away the inner layers of the scales of undoubted examples of this genus, in the Museum of Practical Geology and in that of the Royal College of Surgeons, the points and ridges of the sculpture remaining imbedded in the rock are easily displayed. The clear recognition of the fact that this elegant structure really characterizes *Glyptolepis* is of great importance, for, in the first place, it enables one to discriminate between *Holoptychius* (whose scales have no semilunar area of backwardly directed points) and *Glyptolepis*, and, in the second place, it places beyond a doubt the justice of Professor Pander's conclusion that the scale figured by Miller in the "Footprints," as appertaining to *Asterolepis*, really belongs to *Glyptolepis*.

Pander states that the rays of the median fins are supported upon long interspinous bones, and that the paired fins are very much approximated; the very long pectorals extending far beyond the bases of the ventrals, which are very broad and strong.

Specimens which I have examined show, that the parietal bones of *Glyptolepis* are large, and, like the frontals, distinct from one another; in their form and relative proportions, these bones very much resemble those of *Holoptychius*. There are three bones in the superior occipital region, one median and two lateral. A triangular, single or divided, squamosal fits in between the parietal, the external of the three superior occipital bones, and some indistinctly defined supratemporal and postorbital plates; again, as in *Holo-*

FIG. 7.

Restoration of *Glyptolepis*.

*ptychius*. In the opercular apparatus, the operculum and sub-operculum are large, subquadrate, and nearly equal in size. There are large dendrodont teeth (very well shown in a large specimen in Sir P. Egerton's collection) upon the inner side of the mandible. The principal jugular plates are large, but no specimen I have seen gives clear evidence of others. There is a well marked lateral line.

Apart from what has been done by Agassiz, Miller, and Pander, I think I can venture to assert from my own investigations that the woodcut fig. 7 gives an essentially faithful restoration of *Glyptolepis*.\* But a comparison of this figure with that of *Holoptychius*, given above, is sufficient to prove the close affinity of the two genera,—in fact, their family relationship.

Pausing now, to look back over the ground which has been traversed, we find that the six genera which have been discussed, viz., *Glyptolæmus*, *Glyptopomus*, *Gyroptychius*, *Holoptychius*, *Platygnathus*, and *Glyptolepis*, possess the following characters in common:—Two dorsals, acutely lobate paired fins (ventrals of *Glyptolepis* ?); principal and lateral jugular plates, and no branchiostegal rays; more or fewer large teeth with grooved bases, and consequently folded dentine; sculptured scales and cranial bones,—among which last are to be noted three occipital plates,—large, distinct, parietals, and equally distinct frontals. In short, they constitute a family of Ganoids, which I propose to call GLYPTODIPTERINI, and which may again be subdivided into two groups, or sub-families, the one, which might be called the rhombiferous Glyptodipterini, containing the genera *Glyptolæmus*, *Glyptopomus*, and *Gyroptychius*, with diphyccercal tails, and for the most part rhomboidal scales; and the other, which might be termed the cycliferous Glyptodipterini, containing *Holoptychius*, *Platygnathus*, and *Glyptolepis*, with heterocercal tails and cycloid scales.

Professor Pander has endeavoured to prove that the teeth known as *Dendrodus* belong to fishes of the genus *Gyroptychius*. The evidence brought forward in support of this view, however, appears to me to be hardly sufficient to demonstrate its accuracy; though I think it extremely probable that the teeth and jaws, which have been referred to the genera *Dendrodus*, *Cricodus*, *Lamnodus*, *Platygnathus*, and *Rhizodus*, will turn out to belong to allies of *Gyroptychius*, or, in other words, to fishes belonging to the family of Glyptodipterini. And again I cannot adopt the family of "Dendrodonts" which Professor Pander has established for *Gyroptychius*, *Cricodus*, &c., partly because, as he defines it, it seems to

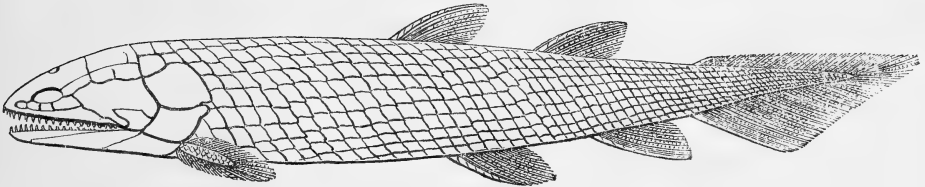
\* It may be that the ventral fins are lobate, but I have seen no specimen justifying that conclusion.

me to separate naturally allied genera, and, still more, because the "dendrodont" character is quite as strongly marked in other fishes, e.g., *Megalichthys*, which certainly do not belong to the same family as *Gyroptychius*, though undoubtedly related to it.

The resemblances which obtain between *Gyroptychius*, on the one hand, and *Osteolepis*, *Diplopterus*, &c. on the other, have been well pointed out by Professor Pander, whose Monograph upon the Saurodipterini is not less excellent than that already cited, though it should not be forgotten that Hugh Miller long ago published an excellent restoration of *Osteolepis*.\* *Diplopterus* has, in fact, the elongated form, depressed head, forward orbits, long gape, and conically tapering caudal end of the body, which characterize *Glyptolæmus*. The pectoral fins are similarly, though not so acutely, lobate, and the lobate ventrals are situated far back, as in the last-named genus. The second dorsal is over the anal, and the caudal fin is rhomboidal and diphycercal.

On the other hand, *Osteolepis*, though similar to *Diplopterus* in many essential respects, has a very inæquilobed tail, much like that of *Glyptolæpis*. But in *Osteolepis*, as in its most nearly allied genera, the cranial bones and the scales are quite smooth. The three occipital plates of the skull remain distinct, but the other bones of the roof of the cranium have coalesced, so as to form two bucklers, an anterior and a posterior; in which, however, the outlines of the primitive cranial bones, which have, on the whole, an arrangement similar to that which obtains in *Glyptolæmus*, are traceable. There

FIG. 8.

Restoration of *Osteolepis* (after Pander).

\* See "The Old Red Sandstone," Pl. iv. fig. 1, *Osteolepis major*. It appears from this figure that even the lobation of the pectoral fin had not escaped Hugh Miller, though he does not particularly refer to it in the text. Before Professor Pander's work appeared in this country, I had obtained from Caithness, by the well-directed activity of Mr. Peach, and placed in the Museum of Practical Geology, a series of specimens illustrating all the chief structural characters of *Osteolepis* as detailed above. The lobate pectorals of *Osteolepis* and *Diplopterus* are exhibited very well by specimens in the Hunterian and British Museum; the fact that "small ganoid scales are continued upon" the bases of the pectorals being noted in the description of No. 567 in the Catalogue of the former Museum.

are no lateral jugular plates, but the principal jugular plates are separated, anteriorly, by an azygos rhomboidal plate.

The family of the SAURODIPTERINI, characterized by its two dorsals; less acutely lobate paired fins; jugular plates and no branchiostegal rays; smooth scales and cranial bones (among which last are three distinct occipital plates, while the other cranial bones have more or less coalesced), is thus very distinct from, though allied to, that of the Glyptodipterini. It comprises not only the genera *Osteolepis*, *Diplopterus*, and *Triplopterus* (?), but also, as I believe, a genus which has a later range in time than these, viz., the *Megalichthys* of the Coal, although the want of acquaintance with the fins of this genus renders my conclusions as to its affinities less secure than I could wish.\* Agassiz does indeed affirm that *Megalichthys* has lobate fins, in a passage cited above (p. 7); but as he merely mentions the fact incidentally, I do not like to lay too much stress upon it. Nevertheless, the skull and scales of *Megalichthys* accord so closely, both histologically and morphologically, with those of the better known Saurodipterines, that I entertain little doubt as to its real place in the latter family.

*Megalichthys* has two principal, many lateral, jugular plates; and a single rhomboidal, azygos plate is placed between the anterior ends of the two principal jugulars. Between the upper margins of the opercula and in the upper occipital region, lie three bony plates, whose signification Professor Agassiz considers to be "somewhat enigmatical," but which really correspond exactly with the three bones which occupy the same position in the Glyptodipterini and Saurodipterini. What Agassiz terms the frontals are certainly the long parietals, whereas those which he calls "ethmoids" are the frontals. His "moignon intermaxillaire" is a crescentic shield, which terminates the head anteriorly, and presents distinct indications of a division into a number of pieces; the contour of the proper premaxillary portions, separated by a median suture, which form the lower and anterior boundary of the shield, being very well defined. The other parts entering into this shield represent, I believe, the prefrontals and the

\* Sir Philip Egerton long since arrived at and published this conclusion in his arrangement of the Fossil Fishes in Morris's Catalogue. More recently Prof. Pander expresses the same conviction in the following terms: "Sehr gerne möchten wir aber ein anderes Genus noch zu den Saurodipteridæ bringen, das durch den Bau seiner Kopfknochen; durch die Gestalt seiner Schuppen, seiner Zähne und hauptsächlich durch die mikroskopische Structur seiner harten Theile sich eng an *Osteolepis* anschliesst und aus der Kohlenformation her stammt. Es ist der Genus *Megalichthys*, von dem wir leider die Beschaffenheit und Lage seiner Flossen gar nicht kennen."—Pander, l. c., p. 5.



ethmoid. If it were amalgamated with the frontals and these with one another, we should have an almost exact reproduction of the anterior cranial buckler of *Osteolepis*. In a well preserved specimen of the skull of *Megalichthys* before me, the orbits are small circular cavities, placed at about the junction of the anterior and middle thirds of the head. They are bounded, in front and below, by a small triangular bone (like a lachrymal) as in *Polypterus*; below, by a small part of a large suborbital bone, whose anterior margin joins the premaxilla and its inferior margin the maxilla; below and behind, by another suborbital bone, fitted in between the preceding, the maxilla, and a postorbital bone. The maxilla, large and long, is narrow anteriorly, where it abuts upon the bone termed "preoperculum" by Agassiz; like the premaxilla, its edges are beset with small teeth. Agassiz says, "Le coté antérieur du mufle est " élégamment échancré au milieu et renflé en un bec, tres obtus, " qui porte dans notre exemplaire une grosse dent canine;" and on making a transverse section of a *Megalichthys* snout I found a median, stout, backwardly projecting ridge of bone, containing two large alveoli, one on each side of the middle line. The one of these alveoli exhibits the section of the base of a large tooth with greatly folded dentine.

While the exoskeleton of *Megalichthys* is exceedingly similar to that of *Diplopterus* and *Osteolepis*, the endoskeleton presents a remarkable advance on that of any other Saurodipterine, in that both the centra and the neural arches of the vertebral column are thoroughly ossified. Excellent specimens of these vertebræ are to be seen in the British Museum.

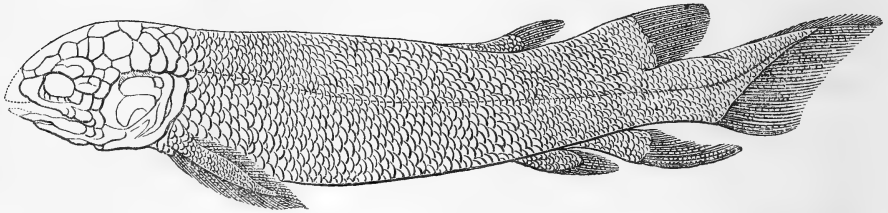
The Saurodipterini and Glyptodipterini being thus separated from other Palæozoic fishes, as well-defined families, perfectly distinct from one another, though closely allied by the community of characters displayed in the number, structure and disposition, of their fins, the absence of branchiostegal rays and their replacement by jugular plates; we have next to consider what other families of fish, if any, should be ranged alongside of them, or in other words, what are the limits and what the importance of the larger group, formed by the association of these families.

In the first place, I conceive there can be no doubt that the CTENODODIPTERINI, a family justly established by Professor Pander\* for the reception of *Dipterus* and its immediate allies, must take its place in close juxtaposition with the Saurodipterini and Glypto-

\* Under the name of *Ctenodipterini*. Sir Phillip Egerton has, I think, given good reasons for the slight change I have adopted. *Vide infra*, p. 55.

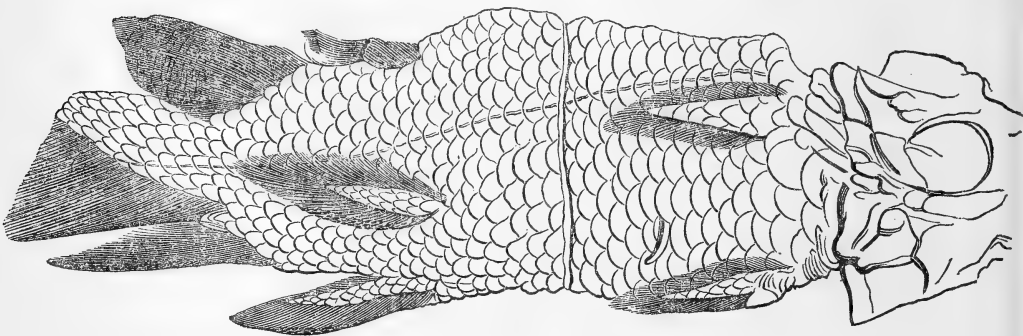
dipterini, seeing that it possesses all those structural peculiarities which are common to these two families. In fact, as Hugh Miller\* originally pointed out in successive notices, *Dipterus* has the dorsal

FIG. 9.

Restoration of *Dipterus* (after Pander).

fins placed far back; acutely lobate pectorals and ventrals; † no branchiostegal rays, but jugular plates instead of them; and a single anal. The caudal extremity of the body tapers off to a point, and has the lower lobe of the fin very much larger than the

FIG. 10. †

*Dipterus*.

upper; the scales are cycloid. Thus far, in fact, the definition of *Ctenodipterini* agrees with that of the *Glyptodipterini*; but the

\* See "Old Red Sandstone," "Footprints of the Creator," and "Sketch Book of Popular Geology." It is much to be regretted that Professor Pander should have been wholly unacquainted with these works when he wrote his Monograph on the *Ctenodipterini*, and that he has consequently inadvertently failed to do justice to the great merits of Hugh Miller, who made known almost the whole organization of *Dipterus*, and anticipated the most important part of Prof. Pander's labours in this field.

† See Prof. Pander, l. c.

‡ The woodcut, fig. 10, represents the same specimen as that figured by Sir Philip Egerton in "Siluria," ed. 2, p. 287, but of the natural size. It exhibits the characters of the paired fins of *Dipterus* remarkably well.

former differ from the latter in the smoothness of their scales; in the structure of the roof of the cranium, whose constituent bones are anchylosed into a singular shield, presenting some resemblance to the cephalic shield of *Accipenser*; and lastly, and chiefly, in the peculiar form of the lower jaw, which much resembles that of a *Cœlacanth*, and in their dentition, so well made known by Hugh Miller, whose researches have been fully confirmed by Professor Pander.

In the next place, the true *Cœlacanthini* have a no less well-defined right to occupy a similar position.\* I say the *true* *Cœlacanthini*, because the term "*Cœlacanth*" has been used by different palæontologists with such very different meanings, has been made in some cases to include so much, and in others to include so little, that I feel it to be necessary to define precisely the sense in which I employ it here. I intend it, then, to designate that family of fishes of which the genus *Cœlacanthus* of Agassiz is the type, a family which, thus restricted, is as well defined and natural a group as any in the animal kingdom, but, at present, can embrace only the genera *Cœlacanthus*, *Undina*, and *Macropoma*.

In order to make this clear, however, I must enter at some length into a historical and anatomical criticism of the *Cœlacanth*s as a family of fishes.

In establishing this family ("Recherches," vol. ii. p. 168), Professor Agassiz dwells particularly upon the hollow fin rays of the typical genus; the absence of joints in some part of the length of most of those fin rays; the presence of interspinous bones in the caudal fin; the continuation of the vertebral column between the two lobes of that fin, and the prolongation of the caudal extremity beyond it as a filamentary appendage. With *Cœlacanthus*, *Undina*, *Macropoma*, *Hoplopygus*, *Uronemus*, *Holoptychius*, *Glyptosteus*, *Glyptolepis*, *Psammolepis*, *Phyllolepis*, *Ctenolepis*, and *Gyrosteus* are associated; and it is a curious circumstance that while *Holoptychius* takes its place among the *Cœlacanth*s, without any special demonstration of its right to that position, Professor Agassiz hesitates touching *Macropoma*, and, while admitting it into the family on

\* Several years ago Sir Philip Egerton strongly drew my attention to the close affinity between the *Cœlacanthini* (*mih*i) and what I have termed the *Glyptodipterini*, particularly showing the importance of the lobate paired fins and of the double dorsals common to the genera of both families (which Sir Philip Egerton was inclined to group under the one head of '*Cœlacanth*s'), and illustrating his views by a synopsis of the genera. From the study of that synopsis I trace the gradual clearing up of my own ideas respecting the difficult subject with which this preliminary essay attempts to deal.

account of the striking analogy of its general physiognomy, and of the form, arrangement, and structure of its fins, adds: "I must admit that side by side with these resemblances, the two types exhibit profound differences," . . . "which will perhaps, in the long run, necessitate another arrangement."

The idea that *Cœlacanthus* inclined more to *Holoptychius* than to *Macropoma*, appears to have found still more favour with Professor Agassiz at the time of the publication of his great work on the Fishes of the Old Red Sandstone; and the consequences of this inclination were the more important from the fact, that Agassiz held that the teeth, properly distinguished by Professor Owen under the name of *Rhizodus*, belonged to *Holoptychius*. For *Glyptolepis* and *Platynathus* were undoubtedly closely allied to *Holoptychius*, while *Dendrodus*, *Lamnodus*, and *Cricodus* had much in common with *Rhizodus*; hence, as these dendrodont teeth were conceived by Agassiz to belong to the fish whose bony plates and scales had received the names of *Asterolepis*, *Bothriolepis*, &c., it was natural that he should include all these genera under the common title of "Coelacanth;" while *Macropoma* and *Undina* were regarded with doubt, and, in fact, almost excluded from the group ("Vieux Grès Rouge," p. 64).

Here, however, I cannot but believe, that the founder of fossil ichthyology has, for once, gone off upon a wrong scent. For later investigations have made it, to say the least, extremely improbable that *Asterolepis* (Ag. & Miller) has anything to do with *Cricodus*, or with *Holoptychius*, whatever may be the relation of the two latter genera; and I shall now endeavour to prove that, while *Cœlacanthus* is so intimately connected with *Undina* and *Macropoma*, as to render the generic distinction of the three forms a matter of minute detail, its relations with *Holoptychius*, although clear and distinct so far as they go, are, at most, those of a member of the same suborder.

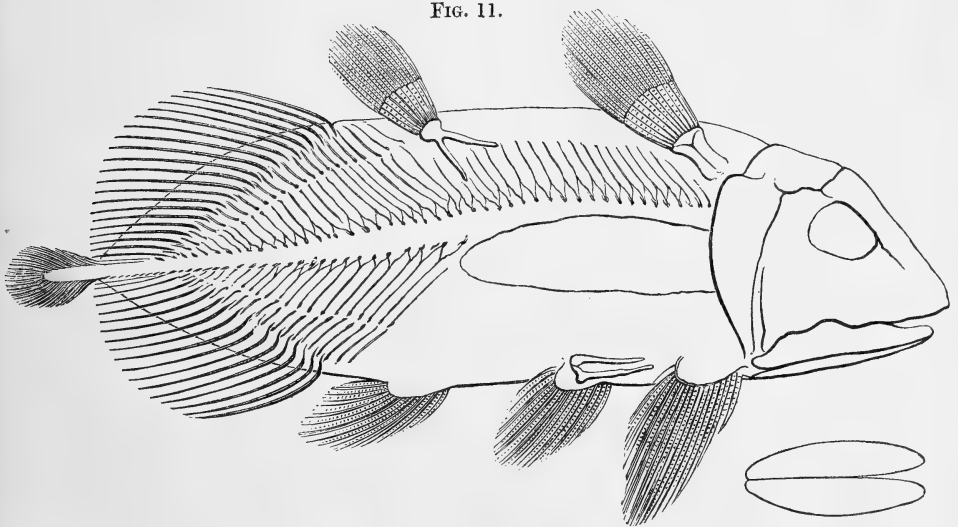
But first, what are the characters of the genus *Cœlacanthus*? This question is by no means so easily to be answered as might be imagined, but the following facts appear to furnish a conclusive reply to it.

The type species of *Cœlacanthus*, that on which the genus was founded by Agassiz, is the *C. granulatus* of the Magnesian Limestone; two figures of which are to be found in the "Recherches," while a third, representing another specimen, is given by Sir Philip Egerton in King's "Permian Fossils." Singularly enough, neither of these specimens retains its head, nor are the paired fins preserved;

but the characters of the spinal column, of the median fins, of the scales, and of the tail, are so exactly those exhibited by the *Undina* of Münster (of which sundry complete specimens exist), that the very close affinity of the two genera is beyond doubt. Agassiz, in fact, proposes to distinguish them only by their teeth; *Cœlacanthus* having, in his opinion, conical and recurved, while *Undina* has flat, pavement-like and tuberculated teeth. That Münster was correct in assigning such teeth to *Undina* I have satisfied myself by the examination of a well-preserved specimen of *U. Köhleri* in Lord Enniskillen's collection; but what evidence is there that *Cœlacanthus* has a different dentition? Agassiz was led to believe that the teeth of the latter genus are conical, by the fact that the specimen of a fish named by him *C. Münsteri* has such teeth. I am again indebted to the Earl of Enniskillen, of whose collection this specimen forms a part, for the opportunity of verifying the statement; but I must at the same time express my entire concurrence in the opinion previously expressed to me by Sir Philip Egerton, that the so-called "*Cœlacanthus*" *Münsteri* is not a *Cœlacanthus* at all.

For, as I have stated above, there can be no doubt that *Cœlacanthus* (*C. granulatus* being the typical species) was, in all the great features of its organization, similar to *Undina*; so that, contrariwise, any fish which differs in essentials very widely from *Undina* can be no *Cœlacanthus*.

FIG. 11.

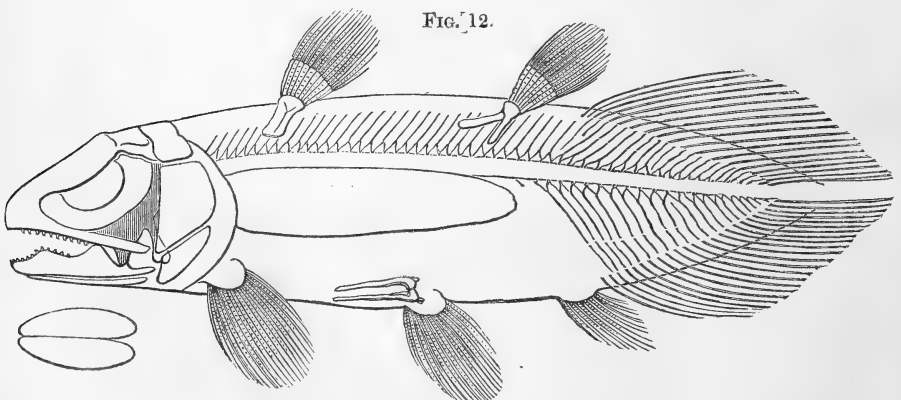


Restoration of *Undina*. (Partly after Münster, partly from Lord Enniskillen's specimen. Below the head are the contours of the jugular plates.)

But *Undina* has two dorsal fins, each supported by but a single, very peculiarly shaped, interspinous bone ; it has a large caudal fin, whose rays are supported by interspinous bones, and which is divided into two equal lobes by the unossified spinal column ; the latter extending beyond the caudal fin as a tufted appendage, or second caudal, provided with very short fin rays. There is a single anal fin ; the pectoral and ventral fins are well developed and obtusely lobate ; the pelvic bones are remarkably large, and are united together by transverse branches, which extend from the posterior extremities of each and meet in the middle line ; there are no dorsal ribs and no proper branchiostegal rays, but instead of them, two broad principal jugular plates. Finally, the scales, large, thin and cycloid, are ornamented with elongated splashes and dots of enamel. On the other hand, "*Cœlacanthus*" *Münsteri* exhibits no one of the positive characters here enumerated, while it *has* ribs attached throughout the dorsal region ; in fact, I am inclined to consider it the type of a new genus allied to *Phaneropleuron*.

I have seen no specimens of the other species of *Cœlacanthus* enumerated by Agassiz, and I can therefore say nothing about them. But *Cœlacanthus caudalis* (Egerton) is a true Cœlacanth, as I have convinced myself by examination of the specimen, to which the figure in King's "Permian Fossils" does not quite do justice.

As the case stands, then, it appears that there is no evidence that the supposed distinction between *Cœlacanthus* and *Undina* really obtains ; while, on the other hand, a recent careful comparison of well-preserved specimens of *Undina* and of *Macropoma* has convinced me that these two genera are not much less closely allied.



Restoration of *Macropoma*.

All the structural characters, in fact, which have been enumerated above among the peculiarities of *Undina*, are equally well marked in *Macropoma*, except that, hitherto, I have been unable to meet with the caudal appendage in the latter, and that the teeth are more distinct and cylindrical. But further than this, as Dr. Mantell originally suspected, and as Professor Williamson has since demonstrated, *Macropoma* exhibits the peculiarity, without a parallel, so far as I know, among fishes of other families, of having the walls of its air bladder ossified. Now, I find good evidence of the existence of a similarly ossified air bladder, not only in *Undina*, but in a well-preserved specimen of a new genus of Coelacanth from the Lias (described in the subjoined note by Sir Philip Egerton), in the Museum of Practical Geology.\*

\* *Holophagus Gulo*.

Mr. Harrison's specimen wants the anterior portion from the dorsal and pectoral fins forwards. From the insertion of the dorsal fin to the extremity of the tail it measures  $11\frac{1}{2}$  inches, and  $4\frac{1}{2}$  inches in depth. The stomach is distended with a recently swallowed *Dapedius*, and a large coprolite occupies the rectum. The first dorsal fin springs (as in *Macropoma*) from a single disc, resulting from the coalescence of the interneural spines. It contains eight long, thick, undivided, and multiarticulate rays. They are beset with numerous short spines or tubercles. The second dorsal is situated 4 inches behind the first. Between the two is seen a strong bifurcate interneural ossicle, which has been displaced forwards from its proper position at the base of the fin. The second dorsal fin contains sixteen rays. The anterior ones are short and slender. The succeeding ones are long, broad, and multiarticulate, but not tuberculate. The base of the fin is obtusely lobate, with a scaly investment. The pectoral fins are much mutilated. Judging from what remains of them, and from some indistinct impressions, they seem to have been of great size. The anal fin occurs immediately below the second dorsal fin, with which it corresponds in form and structure, but contains many more rays. The ventral fins are mutilated, but their position below the first dorsal fin is indicated by the preservation of a pair of strong T-shaped pelvic bones, having their longer limbs directed forwards, and nearly reaching the base of the pectoral fins. The caudal fin is of great size, and presents in an eminent degree the most special and characteristic feature of the *Cœlacanthus* family, namely, the interposition, in the caudal region, of an interneural between the neural and dermo-neural spines. The base of this spine abuts upon the extremity of the neural spine, and unites with the true fin-ray by an overlap or splice. This structure coincides with that observed in *Undina*. In *Macropoma* the bone of the interneural spine is bifurcate for the reception of the distal extremity of the neuropophysis. A small supplemental fin extends an inch beyond the larger caudal fin, as in *Undina* and *Cœlacanthus*. The notochord is unossified. The apophyses, both above and below, have very wide bases. The scales are curvilinear, and covered with a vermiculate pattern on the upper surface, occasionally broken up into small tubercles.

In the Woodwardian Museum at Cambridge there is the head and part of the trunk of a *Cœlacanthus*, from the Kimmeridge Clay at Cottenham. The head shows the frontals, prefrontals, and lower jaw, with the tympanic attachments. The glossohyal plate is double, as in *Holoptychius*. The scales are roughly undulate, coarser in pattern than in *Undina*, *Cœlacanthus*, and *Holophagus*, but not absolutely tuberculate, as in *Macropoma*. One fin is preserved, probably the left pectoral. It is lobate, broad, and strong. The operculum is triangular, the frontals short, and the prefrontals descend at an abrupt inclination.

Thus, leaving open the question as to the identity of *Cœlacanthus* with *Undina*, and also that whether *Uronemus* and *Hoplopygus* (which I have not seen, and concerning which no details are given by Agassiz) are Cœlacanths, or not; it appears to be certain that fishes closely allied to *Cœlacanthus granulatus*, and known under the generic appellations of *Undina* and *Macropoma*, form an exceedingly well-defined family, to which the term CŒLACANTHINI may with propriety be restricted, and which has ranged in time, with remarkably little change, from at least as early as the Permian formation to the Chalk, inclusive.

The Cœlacanthini, as thus understood, are no less distinctly separated from other fishes than they are closely united to one another. In the form and arrangement of their fins; the structure of the tail and that of the cranium; the form and number of the jugular plates; the dentition; the dorsal interspinous bones; the pelvic bones; the ossified air bladder; the Cœlacanthini differ widely from either the Saurodipterini, the Glyptodipterini, or the Ctenododipterini; but, on the other hand, they agree with these families and differ from almost all other fishes, in the same respects as those in which the several families just mentioned, have been shown to agree with one another; viz., the number of the dorsal fins, the lobation of the paired fins, the absence of branchiostegal rays, and their replacement by jugular bones.

Their special affinities among these three families appear to me to lie chiefly with the Ctenododipterini: the scales, the arrangement of the teeth, and the form of the lower jaw in the two families presenting many curious analogies.

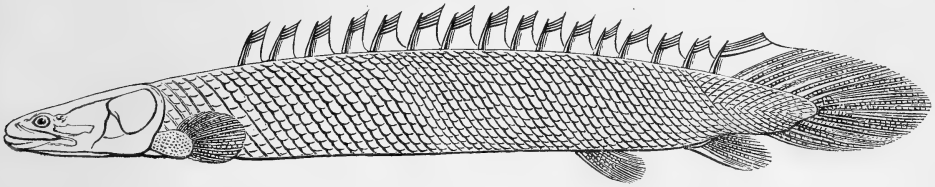
The Glyptodipterine family contains, as we have seen, both cycliferous and rhombiferous genera. Following out the alliances of the former subfamily, we have found reason to include the cycliferous Ctenododipterini and the cycliferous Cœlacanthini in the same larger, or subordinal, group with the Glyptodipterini. If, on the other hand, we now trace out the congeners of the rhombiferous subfamilies, we arrive, as has been seen, at the Saurodipterini; and the question now remains, what other rhombiferous Ganoids naturally arrange themselves at this end of the series?

So far as I am aware, there is no other fossil rhombiferous Ganoid which comes within the scope of the sum of characters common to the Saurodipterini, Glyptodipterini, Ctenododipterini, and Cœlacanthini; but among recent fishes there is one, *Polypterus*, which very nearly approaches the required standard, and is unquestionably closely allied to the Saurodipterini.



*Polypterus*, in fact, has an elongated body, with a depressed head, and a conically tapering caudal extremity. The orbits are

FIG. 15.

Figure of *Polypterus* (after Agassiz).

situated in the fore part of the head, while the gape extends far back. There are two large principal jugular plates, without lateral or median plates. The pectoral arch is covered inferiorly by two triangular osseous plates, which meet in the middle line, and are superficial to the so-called coracoids. The pectoral and ventral fins are lobate. The caudal fin is rhomboidal and nearly diphycceral.\*

A comparison of these characters with those which have been assigned to *Glyptolæmus*, or to *Osteolepis*, reveals at once the close connexion of the three genera,† from which however *Polypterus* differs in many important particulars.

Thus the parietal bones of *Polypterus* are much smaller, in proportion to the frontals, than are those of either *Osteolepis* or *Glyptolæmus*, and with age they unite with one another and with

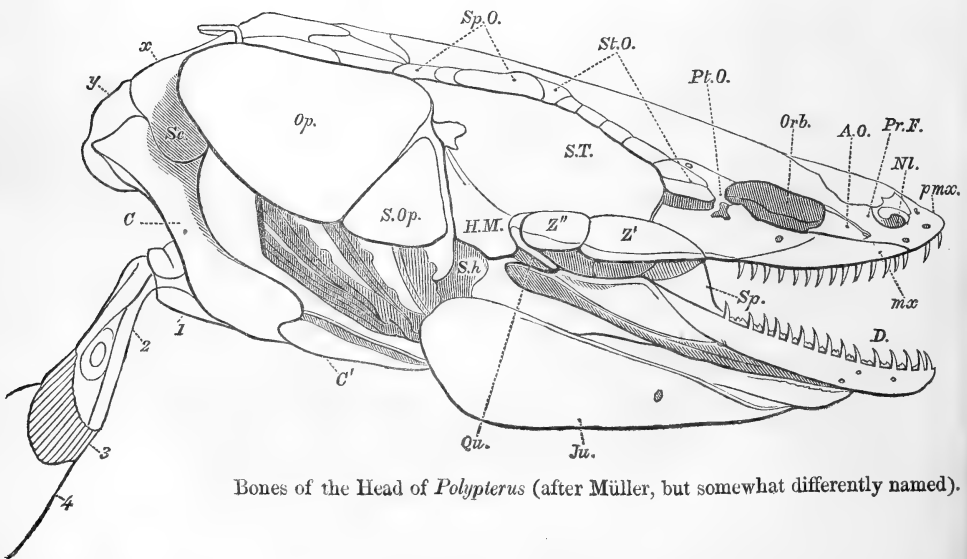
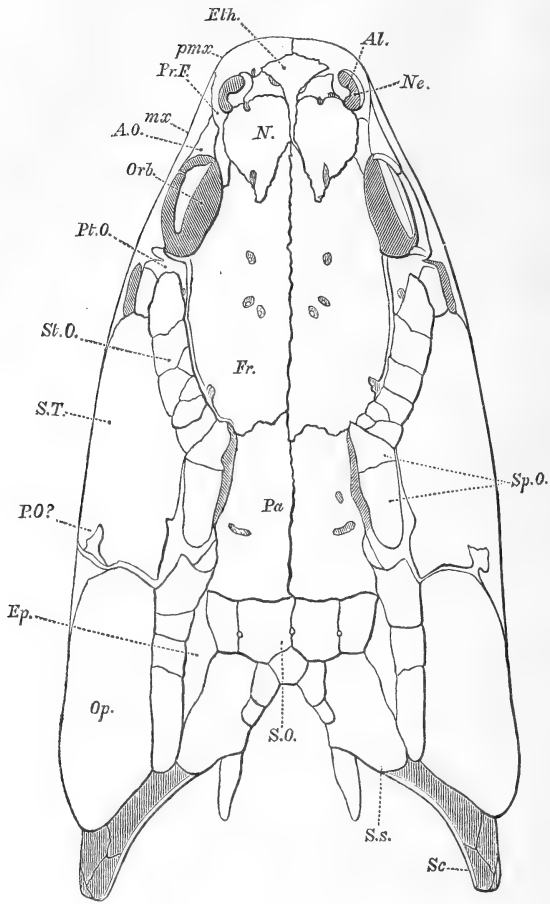
\* See the careful account of the tail of *Polypterus*, by Kölliker, "Ueber das Ende der Wirbelsäule der Ganoiden."

† I do not know that any one has hitherto pointed out in detail the very close relation between *Polypterus* and the fossil genera enumerated above; but Professor Pander has enunciated conclusions nearly similar to my own in the following passage (*Ctenodipterinen*, p. 3.) :—

"Ueberhaupt ist es merkwürdig zu sehen wie *Polypterus* so ganz in den Hintergrund gestellt wird, Herr J. Müller (Ueber d. Bau.) sagt ausdrücklich 'Für den *Polypterus* 'kenne ich unter allen fossilen Ganoiden keine analogie.' Und Herr Pictet wiederholt dasselbe gleichfalls, 'aucun fossile n'a été rapproché de ce genre remarquable.' Wir werden in Zukunft sehen dass wenn man überhaupt ein Recht hat, wie es doch wahrscheinlich ist, die ausgestorbenen Geschlechter der Devonischen Formation jetzt noch lebenden Fischen an die Seite zu stellen, mehrere durch ihre Zahnbau, durch die grossen Knochen-platten und die Stelle der Kiemenhaut-strahlen, durch den Bau der Kopfknochen, u.s.w., eine grössere analogie mit dem *Polypterus* als seinen Amerikanischen Zeitgenossen besitzen."

In his subsequent memoirs Prof. Pander has not followed out to their logical result the views so sagaciously indicated in this paragraph, which I think would be identical with those I had arrived at before I read it, and now publish.

FIGS. 16 and 17.



Bones of the Head of *Polypterus* (after Müller, but somewhat differently named).

the frontals, into a continuous shield, as seems to have been the case in *Dipterus*.

The upper part of the occipital region is covered by a number of more or less irregular plates, which, however, may be readily shown to correspond with dismemberments of the three plates found in the Saurodipterini, &c. There are neither lateral, nor median, jugulars; the teeth have simple pulp cavities; and what is most remarkable, the dorsal fin, instead of being double, is incompletely broken up into a number of pinnules, which extend for nearly the whole length of the back. Furthermore, *Polypterus* has a spiracle, a structure of which I find no trace in any of the fossil genera.

It may conduce to clearness if, before proceeding farther, I now endeavour to put the results of the preceding statements into a readily comprehensible and definite form, and show their bearing upon the classification of the Ganoids, and more particularly upon that of the fossil Ganoidei. To this end I have prepared the following synoptical table:—

### ORDO GANOIDEI.

#### SUBORDO I.—AMIADÆ.

#### SUBORDO II.—LEPIDOSTEIDÆ.

#### SUBORDO III.—CROSSOPTERYGIDÆ.

##### Fam. 1.—POLYPTERINI.

Dorsal fin very long, multifid; scales rhomboidal.

*Polypterus*.

##### Fam. 2.—SAURODIPTERINI.

Dorsal fins two; scales rhomboidal, smooth; fins subacutely lobate.

*Diplopterus*, *Osteolepis*, *Megalichthys*.

##### Fam. 3.—GLYPTODIPTERINI.

Dorsal fins two; scales rhomboidal or cycloidal, sculptured; pectoral fins acutely lobate; dentition dendrodont.

Sub-fam. A. with rhomboidal scales.

*Glyptolæmus*, *Glyptopomus*, *Gyroptychius*.

Sub-fam. B. with cycloidal scales.

*Holoptychius*, *Glyptolepis*, *Platygnathus* [*Rhizodus*, *Dendrodus*, *Cricodus*, *Lamnodus*].

## Fam. 4.—CTENODODIPTERINI. 13

Dorsal fins two; scales cycloid; pectorals and ventrals acutely lobate; dentition ctenodont.

*Dipterus*, [*Ceratodus?* *Tristichopterus?*].

## Fam. 5.—PHANEROPLEURINI.

Dorsal fin single, very long, not subdivided, supported by many interspinous bones; scales thin, cycloid; teeth conical; ventral fins very long, acutely lobate.

*Phaneropleuron*.

## Fam. 6.—CÆLACANTHINI. 15, 20

Dorsal fins two, each supported by a single interspinous bone; scales cycloid; paired fins obtusely lobate; air bladder ossified.

*Cælacanthus*, *Undina*, *Macropoma*.

## SUBORDO IV.—CHONDROSTEIDÆ.

## SUBORDO V.—ACANTHODIDÆ.

Considering the Ganoidei, as defined by Müller, to form an order of the class *Pisces*, and adopting the four groups typified by *Amia*, *Lepidosteus*, *Accipenser* and *Acanthodes*, respectively, as suborders, without thereby prejudicing the question as to whether other suborders may not be required, I propose to establish another and equivalent group, or suborder, to comprise the existing *Polypterus* and all those extinct Ganoids which, like it, fall within the range of the following definition:—

Dorsal fins two, or, if single, multifid or very long; the pectoral and usually the ventral fins, lobate; no branchiostegal rays, but two principal, with sometimes lateral and median, jugular plates, situated between the rami of the mandible; caudal fin diphycceral, or heterocercal; scales cycloid or rhomboid, smooth or sculptured.

On the suborder thus defined I propose to confer the title of CROSSOPTERYGIDÆ,\* in consideration of the peculiar manner in which the fin rays of the paired fins are arranged, so as to form a fringe round a central lobe, which constitutes so marked a character of all the genera belonging to the group at present known.

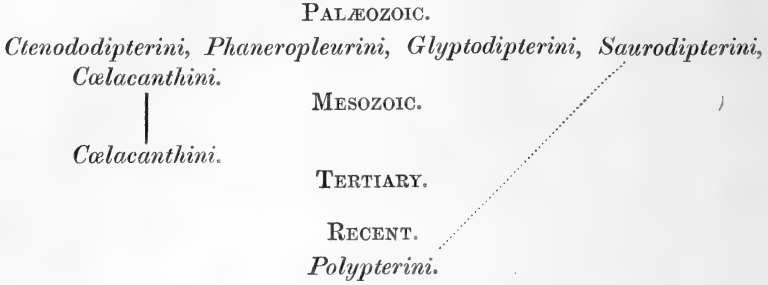
The characters of five of the six families which compose this suborder have been given, incidentally, in the preceding pages, but the table contains another family whose collocation with the rest requires justification.

\* κροσσωτῆς, πτέρυξ, "fringed fin." "Crossopterygidæ" would perhaps be more correct, but the shorter compound is preferable.

This is the family of the PHANEROPLEURINI, which I have established to contain the singular genus *Phaneropleuron*, described at length in this Decade (p. 47) and figured in Plate III. The general character of this fish, its thin cycloid scales, the mode of termination of its caudal extremity, and its remarkable, very acutely lobate, ventral fins, lead me to entertain very little doubt that its right place is among the Crossopterygidæ, and in the neighbourhood of the Glyptodipterini and Cœlacanthini, though I have not yet been able to obtain a very good view of its jugular plates. But the very long, single, dorsal fin, the great length and acute lobation of the ventral fins, which seem to have been longer than the pectorals, and the complete ossification of the costal elements and neural arches throughout the vertebral column, separate *Phaneropleuron* alike from the Glyptodipterini and the Cœlacanthini. From the Ctenodipterini it is separated not only by these characters, but by its dentition. Under these circumstances the only course seems to be to regard it as the type of a distinct family.

The group of Crossopterygidæ, as thus established, appears to me to have many remarkable and interesting zoological and palæontological relations. Of the six families which compose it, four are not only Palæozoic, but are, some exclusively and all chiefly, confined to rocks of Devonian age,—an epoch in which, so far as our present knowledge goes, no fish belonging to the suborders of the Amiadæ or Lepidosteidæ (unless *Cheirolepis* be one of the latter) makes its appearance. Rapidly diminishing in number, the Crossopterygidæ seem to have had several representatives during the Carboniferous epoch, but after this period (unless *Ceratodus* be a Ctenodipterine) they are continued through the Mesozoic age only by a thin, though continuous, line of Cœlacanthini, and terminate, at the present day, in the two or three known species of the single genus *Polypterus*. *Polypterus*, however, is clearly related to the rhombiferous Crossopterygians, or in other words, to exactly that group of whose existence we have no knowledge in any Mesozoic, or Tertiary, formation; while the Ctenodipterini and Cœlacanthini, which depart most widely from *Polypterus*, are those which continue the line of the Crossopterygidæ from the Palæozoic to the end of the Mesozoic epoch. Thus both ends of the Crossopterygian series appear, if I may use the expression, to be cut off from the modern representatives of the suborder; *Polypterus* being separated from those members of its suborder with which it has the closest zoological relations, by a prodigious gulf of time, and from the fossil allies which are nearest to it in time, by deficient zoological

affinity. I may make my meaning more intelligible by a diagram, however.



Here it is obvious that, in time, the Polypterini are twice as remote from their immediate zoological affines, the Saurodipterini and Glyptodipterini, as they are from their more distant connexions, the Cœlacanthini.

It seems singular that while the line of the rhombiferous Crossopterygidæ has so distinct a modern representative, the cycliferous Crossopterygidæ seem to have died and left no issue at the end of the Tertiary epoch. But without wishing to lay too much stress upon the fact, I may draw attention to the many and singular relations which obtain between that wonderful and apparently isolated fish, *Lepidosiren*, sole member of its order, and the cycloid Glyptodipterine, Ctenodipterine, Phaneropterine, and Cœlacanth Crossopterygidæ. *Lepidosiren*

FIG. 18.

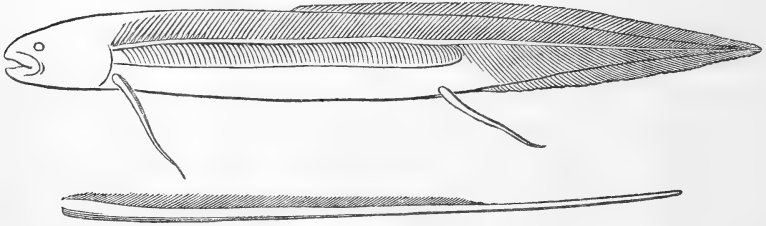


Diagram of *Lepidosiren*. (The lower figure represents the pectoral fin on a larger scale.)

is, in fact, the only existing fish whose pectoral and ventral members have a structure analogous to that of the acutely lobate, paired fins of *Holoptychius*, of *Dipterus*, or of *Phaneropterum*, though the fin rays and surface scales are still less developed in the modern than in the ancient fish. The endoskeleton of *Lepidosiren*, again, is, as nearly as possible, in the same condition as that of *Phaneropterum*, and is more nearly similar to the skeleton of the Cœlacanth than that of any other recent fish; while, perhaps, it is not stretching the search for analogies too far to discover in the

stiff-walled lungs of *Lepidosiren*, a structure more nearly representing the ossified air bladder of the Coelacanth than any with which we are at present acquainted, among recent or fossil fishes. Furthermore, *Lepidosiren* is the only fish whose teeth are comparable in form and arrangement to those of *Dipterus*.\* Though *Lepidosiren* may not be included among the Crossopterygidae, nor even in the order of the Ganoidei, the relations just pointed out are not the less distinct; and, perhaps, they gain in interest when we reflect, that while *Polypterus*, the modern representative of the rhombiferous Crossopterygidae, is that fish which has the most completely lung-like of all air bladders, *Lepidosiren*, which has been just shown to be, if not the modern representative of the cycliferous Crossopterygidae, yet their "next of kin," is the only fish which is provided with true lungs. These are unquestionable facts. I leave their bearing upon the great problems of zoological theory to be developed by every one for himself.

The preceding discussion of the affinities of the Devonian genera, *Osteolepis*, *Diplopterus*, *Glyptolemus*, *Glyptopomus*, *Gyroptychius*, *Holoptychius*, *Glyptolepis*, *Dendrodus*, *Phaneropteron*, *Dipterus*, was an indispensable preliminary to the consideration of the main question with which I proposed to deal in the present essay, viz., What, and how many, groups of fishes are represented in the Fauna of the Devonian epoch? a Fauna which presents a surpassing interest, when we recollect that it comprises the oldest assemblage of vertebrate animals, of which we possess a more than fragmentary knowledge; that its constituents abound in certain localities; and that, for many years past, they have been the subject of careful and repeated collection and investigation. An examination of the data collected up to the present time has led me to the following conclusions, some of which are already current, while others are new:—

1. No vertebrate animal higher in the scale than fishes is as yet certainly known to have been found in any rock of Devonian age. In fact, until demonstrative stratigraphical evidence of the Devonian age of the well-known Elgin beds is obtained, the bearing of the palæontological evidence against that conclusion is too strong to allow of its being entertained.

2. Of the six orders of the class Pisces, three, namely, the DIPNOI, MARSIPOBRANCHII, and PHARYNGOBRANCHII, are certainly not represented by any known Devonian fish. In endeavouring to estimate the value of this negative fact, we must recollect that no fish

\* Prof. Pander has drawn attention to the resemblance of the teeth of his genus *Holodus* to those of *Lepidosiren*, but it is not clear that he regards *Holodus* as a Ctenodipterine.

belonging to either of these orders is at present known in the fossil state; that they are represented by a very small number of genera and species in our existing Fauna; finally, that the Pharyngobranchii, from their very nature, could hardly be preserved in a recognizable state, even in such fine mud as that of the Oxford clay, or the Solenhofen slates; and that of the Marsipobranchii nothing but the horny teeth could be expected to escape destruction. *Lepidosiren*, on the other hand, might have left as definite traces of its existence as *Dipterus*, and hence its entire absence in the fossil state is a negative fact of greater value.

3. The ELASMOBRANCHII abounded, teeth and spines testifying to the numerous and diverse genera which haunted the Devonian seas. It is more difficult to say to what sections of the order these genera belonged, as the only Devonian Elasmobranch whose whole structure can be restored with any certainty is *Pleuracanthus*, a fish which belongs to a family distinct from any now living.

4. The GANOIDEI, as I have endeavoured to show above, are largely represented by a suborder, the Crossopterygidæ, which drops into comparative insignificance in later ages. Of the existence of Amiadæ there is no evidence, and even if we include *Tharsis*, *Thrissops*, and *Leptolepis* under this suborder, they are scanty in all later formations; but what is much more remarkable is the apparent, entire, or almost entire, absence of the Lepidosteidæ, a suborder which obtains such a prodigious development in the Mesozoic epoch. The nature of the Acanthodidæ, and the question whether there is any reason to suspect the existence of Chondrostei during the Devonian epoch will be considered by-and-by.\*

\* The determination of the characters of the families of Lepidosteidæ and of the limits of the suborder is a difficult problem, of which I hope to treat more fully hereafter. One interesting fact results from my investigations, so far as they have hitherto gone, viz., that *Lepidosteus* belongs to a totally distinct family from its Mesozoic allies, whether "Sauroids" or "Lepidoids." The Pycnodonts and Hoplopleuridæ do not appear to me to belong to the Lepidosteidæ, and I doubt their being true Ganoids. For the present I propose the following as a sketch of an arrangement of the Lepidosteidæ.

#### LEPIDOSTEIDÆ.

Heterocercal Ganoids with rhomboidal scales; branchiostegal rays; non-lobate paired fins; a preoperculum and an interoperculum.

##### Fam. 1. Lepidosteini.

Maxilla divided into many pieces; branchiostegal rays few and not enamelled.

#### *Lepidosteus*.

##### Fam. 2. Lepidotini.

Maxilla in one piece; branchiostegal rays many and enamelled; the anterior ones taking the form of broad plates.

(a) *Æchmodus*, *Tetragonolepis*, *Dapedius*, *Lepidotus*, &c.

(b) *Eugnathus*, *Pachycormus*, *Oxygnathus*, &c.

(c) *Aspidorhynchus*.

Perhaps the genera marked a, b, c, should form distinct sub-families.



5. The TELEOSTEI have hitherto been supposed to be entirely absent from formations of Palæozoic age, and no doubt they do not exist under those forms which are most familiar to ichthyologists acquainted with marine fishes, or with the fresh-water fishes of temperate climates; but, nevertheless, I shall now endeavour to show that there are grounds for something more than a suspension of judgment, as to the validity of the ordinary doctrines held upon this subject.

The remarkable genera *Coccosteus* and *Pterichthys* are those which, among all Devonian fishes, have been by common consent regarded as the most heteroclitic and anomalous, some writers having gone so far, in fact, as to imagine that these hard cased vertebrates offered us a transition to the shelled Invertebrata.

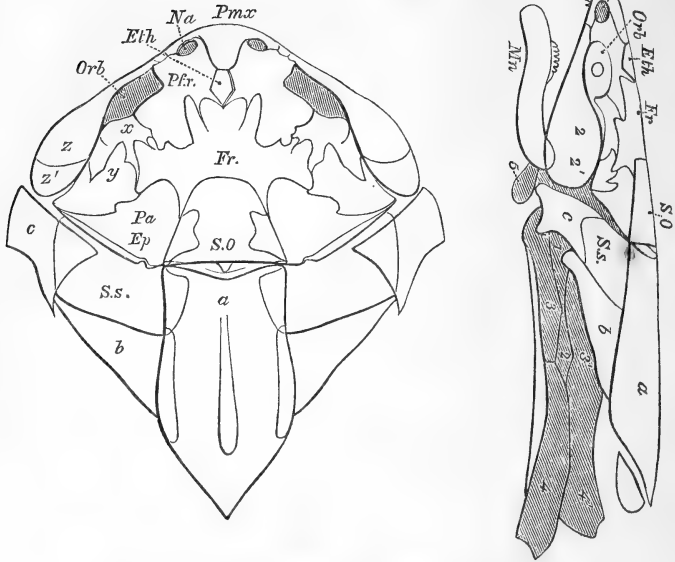
Nevertheless, I trust I shall be able to show that the one of these two closely allied genera—*Coccosteus*—is best, indeed, I may say only, to be understood, by comparing its bony shields with those which cover the roof of the cranium and the anterior part of the body of certain existing Siluroid Teleosteans.

To this end, however, I must first give the conception of the structure of *Coccosteus* which my own investigations, guided by those of my predecessors Agassiz, Miller, Egerton, and Pander,\* have led me to form.

The superior wall of the skull only, seems to have been ossified in this fish, and forms a great shield, which may be roughly said to have a hexagonal figure. The posterior and postero-lateral sides of the hexagon are pretty nearly straight lines, while the anterior side is rounded off, to form the snout, and the antero-lateral sides, the longest of all, have their anterior moieties deeply excavated, to constitute the upper part of the walls of the orbit. From before backwards, in the median line, the contour of the cranial shield is nearly straight, but from side to side it is convex, in consequence, more particularly, of the downward inflexion of its postero-lateral angles. The sutures, which separate the various constituent bones of the skull, may readily be confounded with certain superficial grooves of a totally different import, but, by grinding away the outermost layer of bone, this source of error is avoided; and it is then seen that the cranial sutures have the arrangement represented in the woodcut, fig. 19, and define the several bones from one another with great sharpness.

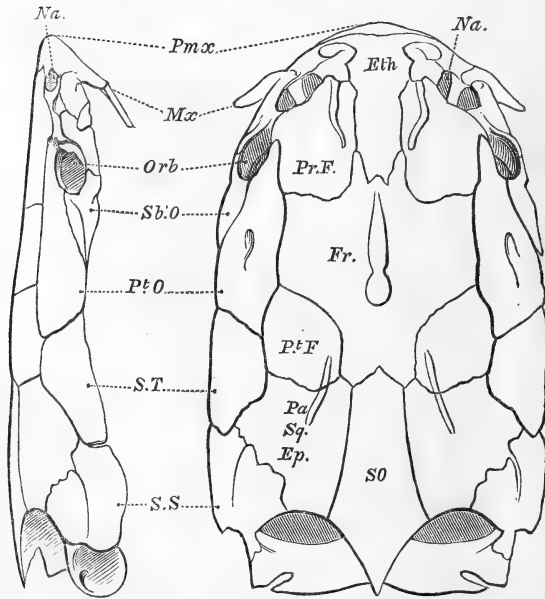
\* Compare Agassiz, "Monog. des Poissons Fossiles du Vieux Grès Rouge;" H. Miller, "Old Red Sandstone" and Quart. Jour. Geol. Soc. 1859; Pander, "Ueber die Placodermen des Devonischen Systems, 1857;" Sir P. Egerton, "Remarks on the Nomenclature of the Devonian Fishes," Quart. Jour. Geol. Soc. 1859.

FIG. 19.



Bones of the head and of the cuirass of *Coccosteus*.

FIG. 20.



Bones of the head of *Clarias*.

In the middle line, behind, they mark off a symmetrical, trapezoidal bone, S.O., which presents a short peg-like process in the middle of its posterior edge, and has a peculiar raised pattern upon its under surface. In front, this bone is articulated with the singular four-rayed bone Fr. The posterior ray (with which S.O. is connected) is the shortest and broadest of the four, while the lateral rays are the longest and the narrowest, the anterior ray holding a middle position in this respect. The edges of the anterior and of the lateral rays are variously indented, apparently to form an interlocking suture with the adjacent bones, while the posterior ray is deeply excavated to unite with S.O. A third bone, much smaller than the preceding, succeeds them anteriorly, and appears to be separated by a transverse suture from a fourth median bone (Pmx.), whose rounded free edge forms the anterior contour of the snout. In well-preserved specimens, this edge is seen to be beset with small, projecting, spine-like tubercles or teeth. The lateral portions of the skull are constituted, proceeding as before, from behind forwards, as follows: a triangular bone (Pa. Ep.), one of whose sides, directed outwards and backwards, forms the postero-lateral side of the hexagon above referred to, unites, by its inner edge, with the bone S.O., and, by its anterior edge, partly with Fr. and partly with another bone (*y*). These edges are irregularly sinuous, and form a squamous suture with the neighbouring bones. The posterior edge of Pa. Ep. presents, near its inner extremity, a sort of socket, with which a peg developed from the plate S.s. is articulated.

An irregularly triangular bone (*y*) is connected with the anterior edge of Pa. Ep., and forms the posterior angle and part of the antero-lateral edge of the skull. It is succeeded by another irregular bone (*x*), which enters into the posterior and upper wall of the orbit, and unites internally with Fr., and anteriorly with a larger and still more irregular bone Pfr. The latter is connected internally with Fr., Eth. and Pmx.; while externally it sends off, rather in front of the middle of its length, a short process, which passes directly downwards and divides the orbital cavity (Orb.) from the nasal cavity (Na.) Extending from the lower end of this process to the postero-lateral angle of the skull, bounding the orbit below, and fitting in by its convex margin, to a concave excavation of the bones *x*, *y*, is a large spatulate bony plate, narrow in front, broad and expanded behind, and composed of two pieces, *z* and *z'*.

The cranio-facial shield thus composed is succeeded by an osseous girdle, which defended the anterior part of the body like the back

and breastplates of a mediæval warrior, and is divisible into two portions, the dorso-lateral and the ventral shields—the former composed of nine pieces, the latter of six. Of the nine pieces of the dorso-lateral shield, seven are closely articulated together, while the other two, small and comparatively insignificant, (and not represented in the dorsal view, fig. 19) were placed loosely at the sides of the posterior end of the great median plate of the seven. This plate *a* corresponds in width, anteriorly, with the cranial bone S.O.; it widens a little behind the middle of its length, and then rapidly tapers to a point. From the middle of its under surface it sends down a strong bony crest, deeper behind than in front, while its lateral edges overlap and unite, by a squamous suture, with the plates S.s. and *b*.

S.s. is a four-sided plate, articulated with Pa. Ep. in the manner before mentioned, while behind it overlaps the triangular plate *b*, and below is overlapped by the plate *c*. The latter is so constantly thrown out of its place in specimens where the connexion between *a*, *b* and S.s. is perfectly retained, that I suspect it rather overlapped than was suturally united with S.s.

The ventral shield appears to me to have had no direct connexion with the dorsal. I have examined a large number of specimens with reference to this point, but I have never discovered the least evidence of a sutural union between any two elements of the two shields, though the respective constituents of each shield are constantly met with in all stages of union and disunion. Of the elements of the ventral shield, two are median and symmetrical, four lateral and in pairs. The two latter, upon each side, are broad at their remote ends and narrower at their adjacent ends, whose outer edges are, besides, somewhat bent up. Of the median plates, the posterior is rhomboidal and articulates with all the others; the anterior has the form of an elongated isosceles triangle, whose base, directed anteriorly, is rounded off and forms the middle of the anterior margin of the ventral shield.

The stout, doubly curved, clavicle-like bones Mn., found, in complete specimens, on the under side of the head, have one edge beset with minute denticles for a short distance; and there are two other flat, elongated, bones, devoid of sculpture upon their outer surfaces, which lie between them and the anterior edge of the ventral shield.

Beside the parts now described, the only other bones known to belong to *Coccosteus* are the neural and subcaudal arches, the fin-rays and their supports, and the curved ossicles which lie just

behind the body armour, and were perhaps connected with ventral fins; but I enter into no particular description of these, as they are not essential to my present purpose.

For some years past I had suspected that the modern Siluroids presented more analogies to the seemingly aberrant Devonian fishes than any other members of the class Pisces, and from the examination of dried specimens, I had even pitched upon the Siluroid genus *Clarias* as that most likely to help me to understand *Coccosteus*; but it was not until my friend and former pupil, Mr. J. J. Monteiro, brought home for me from Congo some specimens of *Clarias capensis* preserved in spirits, that I was able to examine the osseous structure of that fish with sufficient care and thoroughness for the purposes of an efficient comparison.

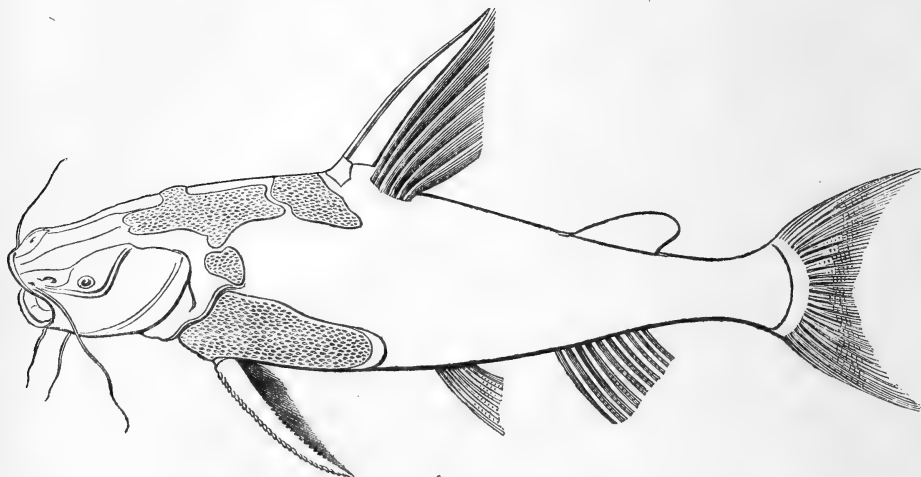
In fig. 20 a careful, reduced representation of the top of the skull of this fish is given, and it will be seen, that in everything but the minor details of form, it agrees with *Coccosteus*. The middle line of the skull is, as in the latter genus, occupied by three bones. S.O., the supra-occipital, is, in the recent form, pointed behind; Fr., the principal frontal, is, as in the fossil, four-rayed; it exhibits a considerable gap or fontanelle, but no median suture; Eth., the ethmoid, and Pmx., the premaxilla, correspond exactly in the two skulls, if we leave out of consideration the position of the suture seen in the fossil in this region. The bone Pr. F., which can be at once identified as the prefrontal in *Clarias*, and which sends down a process dividing the orbit from the nostril, obviously corresponds with the similarly related bone in *Coccosteus*; while in *Clarias* the orbit is completed below by the spatulate suborbital bone, Sb. O., smaller in proportion and undivided, but otherwise similar to the bone *z*, *z'* of *Coccosteus*. The post-orbital bone, Pt. O., and the supra-temporal bone, S. T., of the former appear to have their homologues in the bones *x* and *y* of the latter fish.

The space between the frontal, the supra-occipital, and the supra-temporal is occupied, in *Clarias*, by two bones, the anterior of which certainly represents the post-frontal; while the posterior occupies the situation of no less than three distinct bones in the heads of ordinary fishes, viz., the parietal, the squamosal, and the epiotic. The reduction in the normal number of bones which obtains in the Siluroid has been carried a step further in *Coccosteus*, where the plate lettered for shortness' sake only Pa. Ep. is the only representative of the bones Pt. F. and Pa. Sq. Ep. of *Clarias*.

Lastly, comes the bone S.s. naturally united in *Clarias* to Pa. Sq. Ep. and to S. T., and which corresponds with the supra-scapula

of ordinary osseous fishes, in which it is usually connected with the skull only by ligament. The Siluroids and Ganoids, however, coincide in always having this bone more closely united with the regular cranial bones, and *Coccosteus*, it will be observed, agrees with them.

FIG. 20.

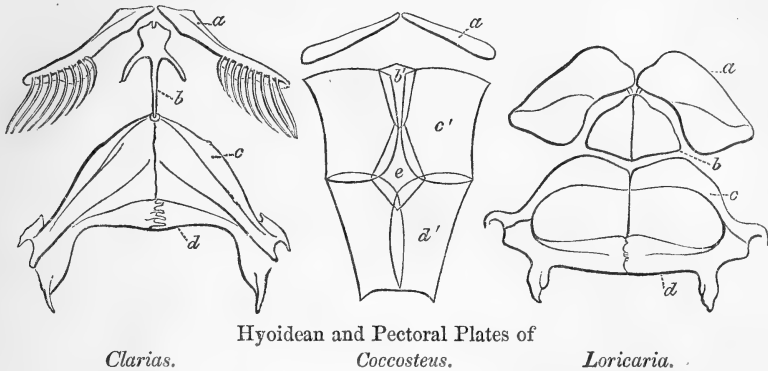
*Arius rita*, after Cuvier and Valenciennes.

So much for the cranial shield. To comprehend the dorsal and ventral body shields we must have recourse, not to *Clarias*, but to other Siluroids, such as *Bagrus*, *Arius*, &c. In these fishes, in fact, the anterior dorsal interspinous bones become so modified as to form a great shield-shaped dermal plate, with a strong inferior crest, which occupies the same position and has the same relations as the medio-dorsal plate of *Coccosteus*, though it commonly bears a strongly articulated spine, which is absent in the latter genus. In some species, as *Arius cruciger*, the principal plate is provided with lateral accessory plates, in which, perhaps, we have the homologues of the dermal plates *b*, of *Coccosteus*. It is possible that *c* may have been the operculum, which occupies a nearly similar position in *Arius*, but if it were suturally connected with the supra-scapula, this view would be untenable, and the bone would have to be regarded as a scapular element.

In the Siluroids to which I have referred, and in *Loricaria*, a vast latero-ventral shield is produced by the prodigious expansion and coalescence of the bony elements which are homologous with those termed "coracoid" and "radius" in other fishes. Viewed from the ventral surface, these bones form four great plates, those

of each side being closely united, or even amalgamated together, while the opposite pairs are joined, in the middle line, by a strongly serrated suture.

FIG. 21.

*Clarias.*

Hyoidean and Pectoral Plates of

*Coccosteus.**Loricaria.*

When the pectoral fin is provided with an anterior spine, this is articulated by a curiously complicated joint with the so-called coracoid. The cornua of the hyoid are large stout bones, and the urohyal, also a large and strong bone, which is particularly broad in *Loricaria*, connects the hyoidean with the pectoral apparatus.

On comparing this apparatus with the sternal shield of *Coccosteus*, one is tempted to compare the antero-median piece of the latter with the urohyal of the Siluroid, the antero-lateral piece with the "coracoid," and the postero-lateral piece with the so-called "radius," the more especially as the antero-lateral piece corresponds with that part of the thoracic shield of *Pterichthys* which supports the plated appendage representing the pectoral fin, in that genus.

On the other hand, it must be confessed that the closer connexion of the antero-median piece with the thoracic plates than with the hyoidean cornua, and the very backward position of the postero-lateral plates, apparently out of reach of any connexion with the fins, militate against this view; which, in addition, leaves the median rhomboidal plate unaccounted for.

The bones Mn. are, of course, as has long been determined, the rami of the mandibles of *Coccosteus*. Their singular figure is not unlike that of the corresponding bones in *Loricaria*. Finally, the long flat bones *a* (fig. 21), I have no doubt, are the chief parts of the hyoidean arch, which are also proportionately large in many Siluroids.

No one, I think, will deny that the structural coincidences here

detailed are of very great weight, and that in the absence of contrary evidence they must lead us to assign a place near, if not among, the Siluroidei to *Coccosteus*. I do not know that any facts which can be adduced can be fitly considered as such directly contrary evidence, but there are several difficulties which require careful consideration.

In the first place, *Coccosteus* seems to have possessed neither basal nor lateral cranial bones,—at least, no traces of such structures have yet been discovered; so that, in all probability, this fish possessed a cartilaginous primordial cranium like that of *Accipenser*; and, indeed, a still more gristly one, for *Accipenser* has a large basal ossification. The hyomandibular suspensory apparatus must have been equally cartilaginous, and, in the vertebral column, only the superior and inferior arches were ossified. Assuredly this is very unlike what we are accustomed to see among the Teleostei, but it must be recollected that it is at least equally unlike what we find in the Ganoids, if we except those of the same epoch; and, on the other hand, there are some recent Teleostei, though there are no known Ganoidei, whose vertebral columns and skulls exhibit a correspondingly low stage of organization.\*

In the second place, arises the question whether, since we know that a true Ganoid, *Amia*, completely simulates the outward form of a Clupeoid Teleostean, while retaining all the essentials of its order,—may not *Coccosteus* be also a true Ganoid which simulates the outward aspect of a Siluroid? To this question it is, perhaps impossible to give any answer, save by asking another, viz. :—Why should not a few Teleosteans have represented their order among the predominant Ganoids of the Devonian epoch, just as a few Ganoids remain among the predominant Teleosteans of the present day? When it is considered that an ichthyologist might be acquainted with every fresh-water and marine fish of Europe, Asia, Southern Africa, Southern America, the Indian Archipelago, Polynesia, and Australia, and yet know of only one Ganoid, the Sturgeon, a fish so unlike the majority of its congeners, that a naturalist might be well acquainted with almost all the fossil Ganoids, and yet not recognize a sturgeon as a member of the group,—it will not seem difficult to admit the existence of a Teleostean among the Devonian Ganoids, even though that Teleostean should in some, even important, points differ from those with which we are familiar.

\* See on this point, however, the remarks at p. 38, under (3).



At any rate, I think the *primâ facie* case in favour of the Teleostean nature of *Coccosteus* is so strong, that it can no longer be justifiable to rank it among the Ganoids, “*sans phrase*,” but that even those who will not allow it to be Teleostean must attach to it the warning adjunct of *incertæ sedis*.

No one doubts that wherever *Coccosteus* goes, *Pterichthys* must follow, and though the structure of the last-named fish is, in some respects, more difficult of interpretation than that of the former, in others it is strikingly Siluroid. For example, I know of no piscine structure that is even remotely comparable to the proximal joint of the pectoral limb of *Pterichthys*, except the corresponding articulation of the pectoral spine and fin of the Siluroids. And again the example of *Ostracion* shows that the box-like cincture of the body of *Pterichthys* is by no means foreign to the Teleostean group, though it cannot be paralleled by fishes of any other order. Whether the other “Placodermi” of Pander, such as *Asterolepis* (Ag. and Miller) really belong to the same group as *Coccosteus* and *Pterichthys*, or not, is a question which can perhaps be hardly settled at present; although, provisionally, I am much inclined to associate them together. In principle, the cranial structure of *Asterolepis*, is very similar to that of *Coccosteus*.

Having disposed of the undoubted Elasmobranchs, of the Cross-ptyerygian Ganoids, and of the “Placodermi” of the Devonian epoch, several important and rather difficult groups remain for discussion. These are the Acanthodidæ, the genera *Cephalaspis* and *Pteraspis*, and the genus *Cheirolepis*.

The ACANTHODIDÆ have hitherto been ranked among the Ganoids, but the following considerations have often led me strongly to suspect that they might be Elasmobranchs:—

1. Their dorsal spines are similar in form and mode of implantation to those of the Elasmobranchii, except perhaps that the surface of the implanted portion is less different from the rest than in the latter order.

2. Their dermal ossicles are more like shagreen than scales.

3. As Roemer has pointed out, their lateral line runs between two rows of these ossicles, and is not formed by separate canals or grooves in successive scales as in most Ganoids and Teleosteans.

4. They seem to have had no distinctly ossified cranial bones.

5. They have no opercular apparatus, but as Sir Philip Egerton long ago pointed out to me, their branchial arches are naked.

6. The sternal part of their pectoral arch seems to have had no bony connexion with the head.

On the other hand, however, it must be considered that,—

1. The Acanthodidæ, unlike all Elasmobranchs, have great spines articulated with the pectoral arch.

2. The dermal plates of the Ganoid *Cheirolepis* are very shagreen-like, though affirmed by Pander to differ in structure from those of Acanthodidæ.

3. The cranial bones become less and less developed in the Chondrosteous Ganoids, until in *Spatularia* they are very thin squamose lamellæ; so that there is no great difficulty in the way of supposing their entire absence in a true Ganoid.

4. In the same way, the opercular apparatus, small in *Accipenser*, is still more reduced in *Spatularia*.

5. The thin, curved, toothless mandibles of *Spatularia* present, perhaps, the nearest analogue to the singular mandibular bones of *Acanthodes*.

6. As Roemer has pointed out, *Paleoniscus* has orbital plates very like those of *Acanthodes*.

7. The production of the pectoral arch into long backwardly directed processes in *Diplacanthus* and *Cheiracanthus* is the very reverse of an Elasmobranch character, seeing that the like only obtains, so far as I know, in some Siluroids.

8. *Acanthodes* is provided with two very long filaments, beset with short lateral branches, which proceed from the region of the mouth, and such oral tentacles are to be found only in Ganoids and Siluroids.

Under these circumstances the safest course probably is to regard the Acanthodidæ as a distinct suborder of Ganoids.

The genera *Cephalaspis*, *Pteraspis*, *Auchenaspis*, and *Menaspis* certainly form a family by themselves, to which the title of CEPHALASPIDÆ may be conveniently applied; but the position of this family is not readily determinable. No one can overlook the curious points of resemblance between the Siluroids, *Callichthys* and *Loricaria*, on the one hand, and *Cephalaspis*, on the other, while in other respects, they may be still better understood by the help of the Chondrostean Ganoids. Compare, for example, *Scapirhynchus* with *Cephalaspis*, or the great snout of *Pteraspis* with that of *Spatularia*. I am inclined to place the Cephalaspids provisionally among the Chondrostei, where they will form a very distinct family.

The affinities of two genera remain for discussion, the one being the well-known *Cheirolepis* of Agassiz, the other, the new genus

*Tristichopterus*, described by Sir Philip Egerton in the course of the following Decade.

*Cheirolepis* contains fishes with moderate-sized heads and markedly heterocercal tails; with a single dorsal fin, a single anal, pectorals, and ventrals. The median fins are situated forwardly, the dorsal being over the posterior part of the anal; and the ventral fins are so forward as to be almost close to the pectorals. None of these fins are lobate. The body is covered with minute rhomboidal scales, which do not overlap one another, so that the skin has quite the aspect of shagreen. Nevertheless, according to Pander, the structure of these bony scales is not so like that found in the Squalidæ as that of the scales of *Diplacanthus*.

The head is usually crushed, and its component elements displaced, but according to Professor Pander, whose account is largely borne out by the specimens I have examined, the middle of the roof of the cranium, from the posterior edge of the occiput to the anterior edge of the frontal region, is covered by two broad bony plates, which were, perhaps, divided in the middle line. Pander considers the anterior of these to be frontals, the posterior, to be parietals. At the sides of the parietals lie three narrow bones, which, perhaps, all belong to the skull, though the inner and uppermost may appertain to the shoulder girdle. The anterior edges of the other two bound the orbit posteriorly, and similarly elongated plates lie in front of the eyes, beside the frontals. The upper jaw is a large bone, rounded off posteriorly and tolerably broad behind, while anteriorly its upper edge suddenly becomes excavated to form the lower boundary of the orbit and then tapers off; it is beset with small sharp conical teeth. The gape extends very far back, and the lower jaw is a long flat bone toothed like the upper.

According to Agassiz, there were larger teeth interspersed among the smaller ones ("Recherches," p. 130; "Vieux Grès Rouge," p. 44), but all in a single row. Like Pander (l. c., p. 73), I have been unable to discover these larger teeth. The opercular apparatus and the branchiostegal rays, or their representatives, were not observed by Pander, nor have I seen indubitable evidence of their characters; but Agassiz ("Recherches," p. 132) has described and figured the branchiostegal rays of *Ch. Uragus*. "The branchiostegal rays are very well preserved on both sides of the head; the anterior are shorter and larger; they are well seen on the left side. The posterior ones, which are better preserved on the right side, are narrower and more elongated. I count at least ten of them."

According to Pander a large perforated plate surrounds the eye.

Miller, Giebel, and Pander have agreed upon the propriety of separating *Cheirolepis* from the other Acanthodidæ of Agassiz, and Pander proposed to form for it a distinct family, that of the CHEIROLEPINI. Granting, as I think every one must do, the justice of this step, the question next arises in what suborder of the Ganoids does this family arrange itself.

It certainly is not one of the Crossopterygidæ, for it has but a single, comparatively short, dorsal fin, neither pectorals nor ventrals are lobate, and there are no jugular plates; still less can *Cheirolepis* be ranked among the Amiadæ or Chondrosteidæ. On the other hand, it presents certain points of resemblance with *Paleoniscus*, and through those forms connects itself with that large body of fossil fishes which have more or less direct relations with *Lepidosteus*. Perhaps then, *Cheirolepis* ought to be regarded as the earliest known form of the great suborder of the Lepidosteidæ.

In the absence of a full knowledge of the head, of the paired fins and of the dentition, it would be hazardous to form any decided opinion as to the affinities of *Tristichopterus*; I strongly suspect, however, that it will turn out to be the type of a new family allied to the Ctenododipterini and Cœlacanthini.

The cranio-facial bones are lettered as follows in the woodcuts:—

|                               |                                        |
|-------------------------------|----------------------------------------|
| <i>S. O.</i> Supra-occipital. | <i>Mx.</i> Maxilla.                    |
| <i>Fr.</i> Frontal.           | <i>Pmx.</i> Premaxilla.                |
| <i>Eth.</i> Ethmoid.          | <i>H. M.</i> Hyomandibular bone.       |
| <i>Ep.</i> Epiotic.           | <i>Qu.</i> Os quadratum.               |
| <i>Pa.</i> Parietal.          | <i>S. S.</i> Supra-scapular.           |
| <i>Sq.</i> Squamosal.         | <i>Op.</i> Operculum.                  |
| <i>Pt. F.</i> Post-frontal.   | <i>S. Op.</i> Sub-operculum.           |
| <i>Pr. F.</i> Pre-frontal.    | <i>Ju.</i> Jugular bones.              |
| <i>S. T.</i> Supra-temporal.  | <i>Sp. O.</i> Spiracular ossicles.     |
| <i>Pt. O.</i> Post-orbital.   | <i>St. O.</i> Supra-temporal ossicles. |
| <i>Sb. O.</i> Sub-orbital.    |                                        |

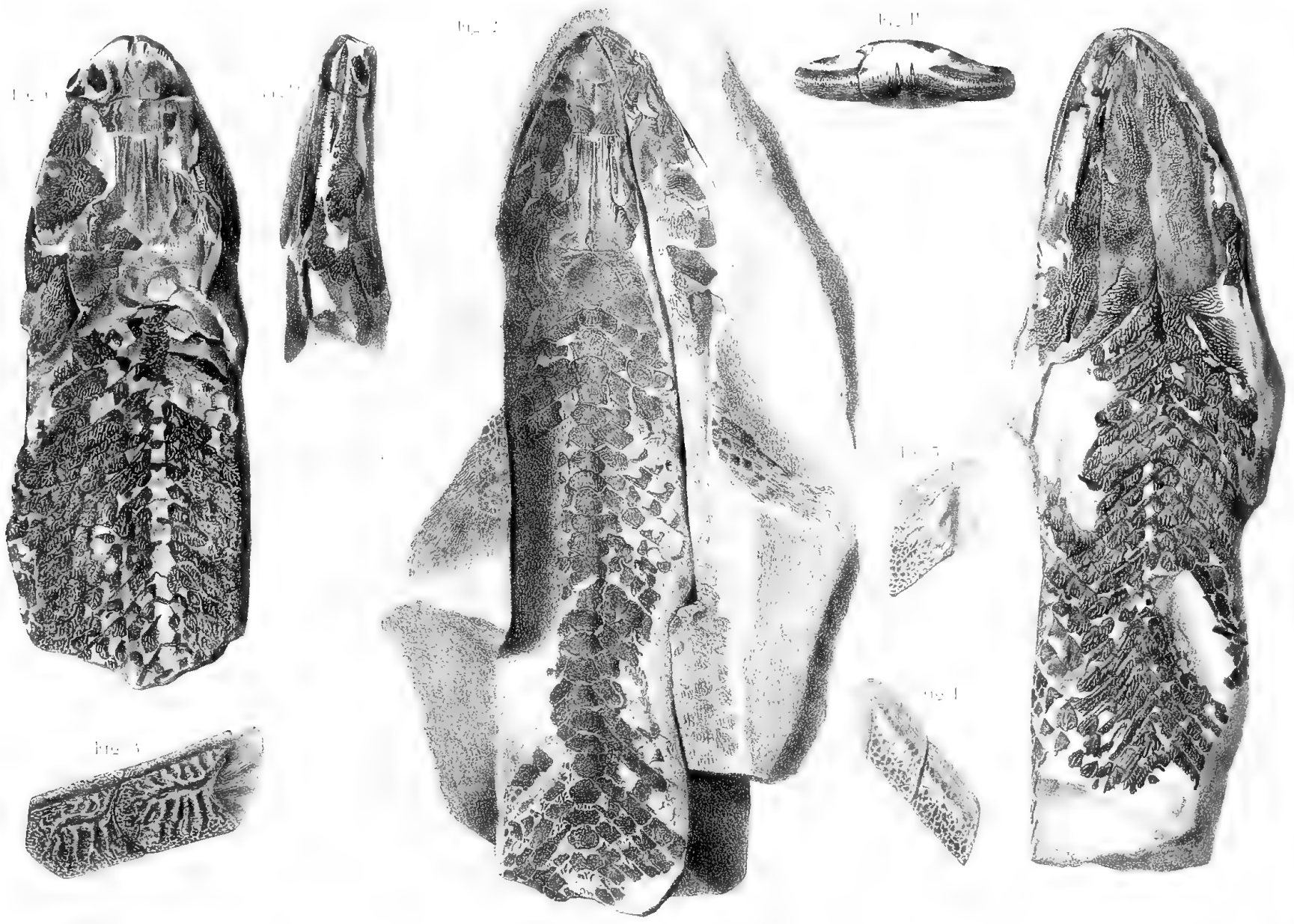
P.O. "Pre-operculum" occurs in the woodcut, fig. 2; but I am now much inclined to doubt the existence of a true pre-operculum in any Crossopterygian fish.

T. H. HUXLEY.

*Jermyn Street, Nov. 1, 1861.*

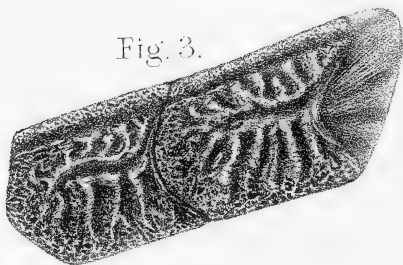
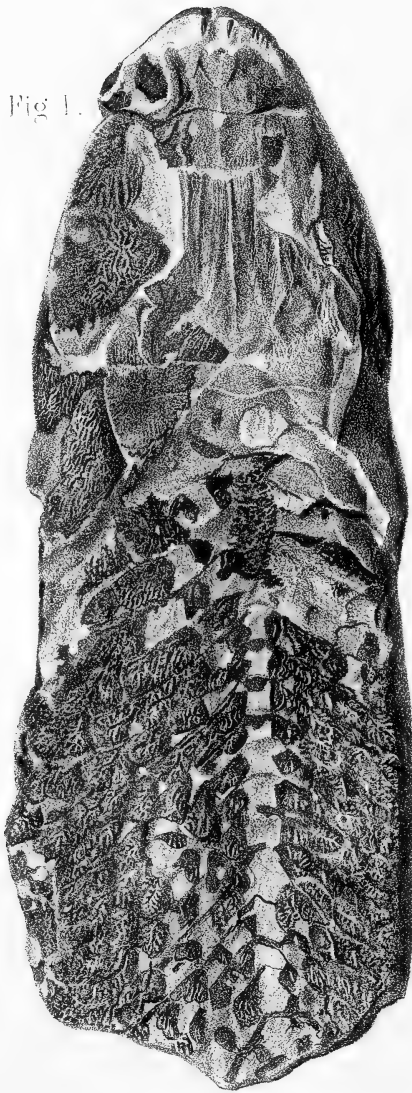
[NOTE.—By the great kindness of Dr. Taylor of Elgin, I have just had the opportunity of examining a beautiful, almost entire, specimen of *Glyptopomus*, with two dorsal, and exquisitely lobate pectoral, fins.—T. H. H., Nov. 18th.]





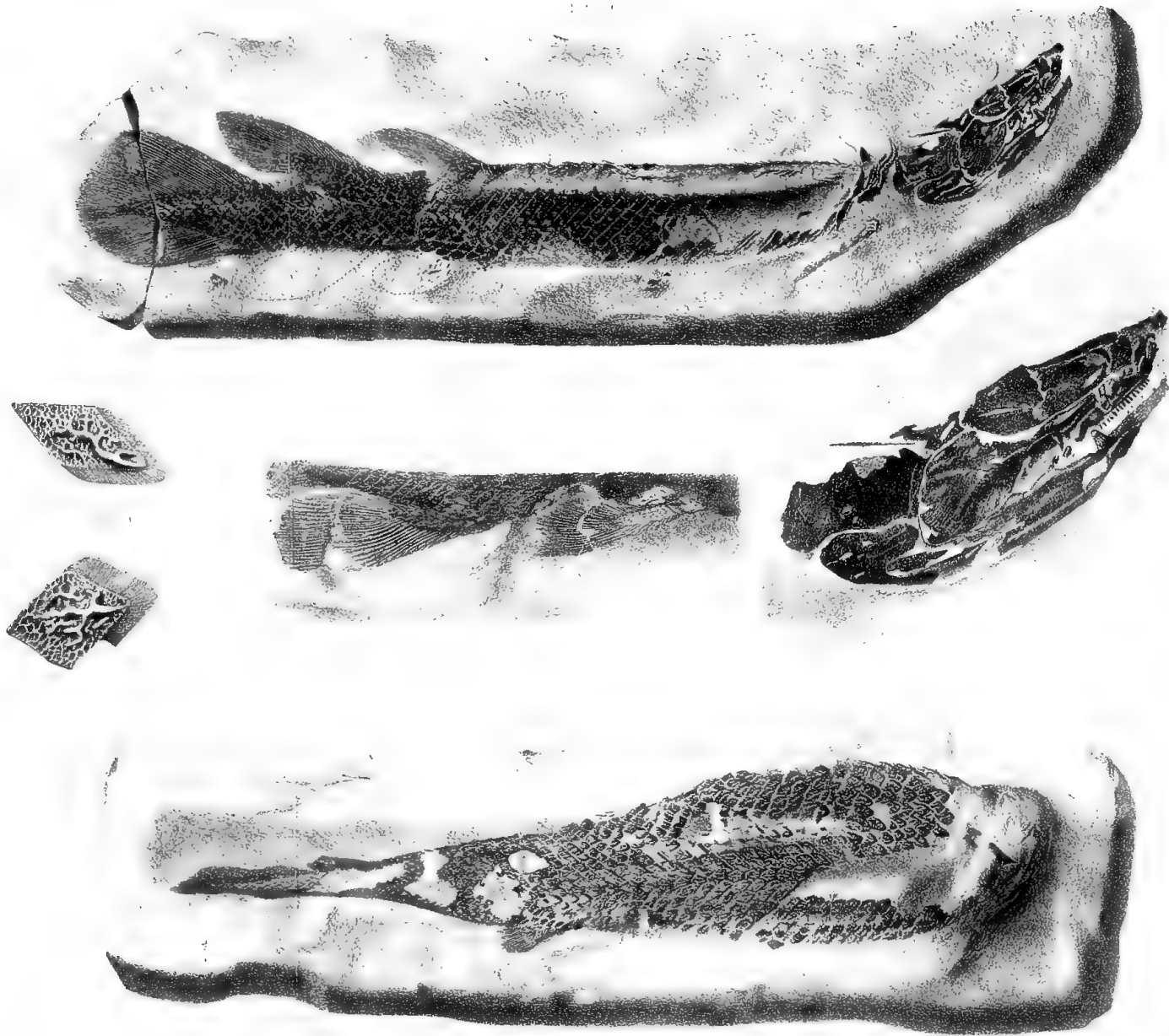
GLYPTOLOEMUS KINNAIRDI *Hurley*













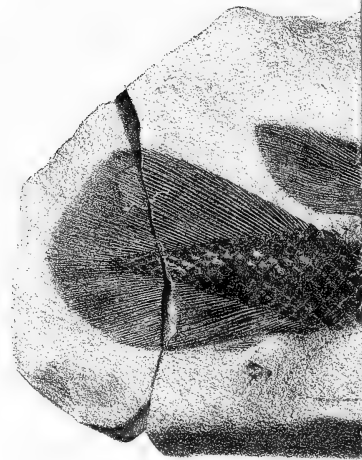


Fig 4

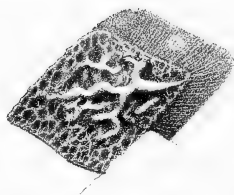


Fig 1a



# BRITISH FOSSILS.

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## DECADE X. PLATES I. AND II.

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### GLYPTOLÆMUS KINNAIRDI.

[Genus GLYPTOLÆMUS. HUXLEY. (Sub-kingdom Vertebrata. Class Pisces. Order Ganoidei. Suborder Crossopterygidaë. Family Glyptodipterini.) Body elongated, tapering to a point posteriorly. Cranium depressed. Dorsal fins two, distinct, situated in the posterior two-fifths of the length of the body. Ventral fins under the first dorsal, and like the pectorals lobate. The rhomboid scales and the cranial and facial bones ornamented with raised ridges. Teeth of two sizes, composed of (probably) dendrodentine. Tail diphycercal.]

*Glyptolæmus Kinnairdi.* SP. UNICA.

Specimens of this genus were first described, and their distinctive characters pointed out by me, in a notice inserted in Dr. Anderson's work upon "Dura Den," which was accompanied by excellent, though small, illustrative figures, drawn by Mr. Dinkel.

Since 1859, thanks to Dr. Anderson's zeal and activity, a number of additional specimens, several of great beauty and interest, have passed into the collection of the Museum of Practical Geology, so that I am now in a position to give a tolerably complete account of the structure of these ancient fishes. The singularly beautiful and accurate figures in Plates I. and II. will enable the reader, step by step, to verify for himself the most important points of my description.

The body is, as I have said, elongated, and when viewed sideways, fusiform, tapering to a point at each extremity (Plate I. fig. 1), but when viewed from above or below, though the caudal extremity is still seen to end in a point, the anterior part of the body rapidly widens (Plate I. fig. 3), and ends in a depressed, broad, and shovel-shaped head, with a semi-elliptical contour, rounded at the snout.

The length of the whole body is about four and a half times as great as the distance from the end of the snout to the posterior margin of the opercular apparatus; which distance exceeds by as much as a fourth, or a fifth, the transverse diameter of any part of the body. It somewhat exceeds, again, the perpendicular distance

from the upper margin of any part of the dorsal, to the lower margin of any part of the anal fin. The greatest transverse diameter of the head is equal to the distance from the snout to the posterior margin of the parietal bones.

The specimen figured in Plate II. furnishes a very complete view of the structure of the cranium of *Glyptolæmus*, the arrangement of whose constituent elements is still further elucidated by the diagrammatic woodcuts fig. 2 (p. 2 of the "Preliminary Essay") made from enlarged and restored views of the skull and its appendages.

The cranial bones are thin and scale-like, and their surface exhibits numerous long and sinuous ridges, separated by narrow and comparatively deep grooves, which sometimes obscurely radiate from the centre of the bone.

The premaxillary bones, slender and slightly curved, uniting in a broad, but short, ascending internasal process, form the anterior boundary of the snout and limit the nostrils below, joining the equally slender maxillaries which constitute the rest of the upper boundary of the gape behind. The upper and inner edges of the ascending processes of the premaxillaries abut against the anterior margins of a flat hexagonal bone, whose posterior margins unite with the frontals, while its lateral edges are connected with the inner edges of the nasal bones. This bone is therefore obviously the ethmoid.

The frontals, which succeed the ethmoid in the middle line, are short, but comparatively narrow bones, separated by a very distinct suture, which widens in the middle of its length, so as to form a small rhomboidal fontanelle. The posterior edges of the frontals are truncated, and unite with the anterior margins of the parietals, which are almost twice as long as the frontals, and enter more largely than any other bones into the formation of the roof of the skull. The left parietal rather overlaps the right posteriorly, and each parietal suddenly widens in its posterior moiety, so that its outer edge presents a deep notch or step into which the post-frontal fits. The posterior edges of the parietals are as abruptly truncated as the anterior. They unite in the middle line with the apex of the large rhomboidal scale, or bone, which occupies the place of the supra-occipital.

The supero-lateral regions of the skull are formed in front by the large nasals; behind these by the prefrontals, which unite with the maxilla, the nasals and the frontals below, in front and above, and apparently, with the post-frontal behind. Their posterior excavated margins form the anterior boundary of the orbit.

The post-frontals, better defined posteriorly than anteriorly, appear to join the prefrontals, and then, extending backwards beyond the posterior margins of the frontals, they unite with the anterior moiety of the parietals, filling up all that notch in the outer border of these bones, which has been described. Their posterior edges are connected, internally, with the anterior margins of the projecting part of the parietal, externally with the same margins of the small quadrilateral squamosal bones.

The posterior part of the supero-lateral region is completed by two squamiform bones, which take the place of the external occipital, or epiotic, bones of other fishes, filling the interspaces left between the supraoccipital and the opercular apparatus. The inner surface of this bone, on the left side, presents a very well marked triradiate impression, one crus of which is directed transversely inwards, while the others are respectively directed forwards and backwards. A shallow groove upon the surface of the supraoccipital, which has a slight concavity forwards, connects the transverse crus of the impression on one of these bones with that on the other.

The triradiate marks are much more distinct upon the inner surface of these bones, where they form distinct ridges, than upon the outer surfaces, where they appear only as very shallow and indistinct grooves; and, except for the continuation of each transverse crus into its fellow across the supraoccipital, I should have been disposed to connect them rather with the semicircular canals of the auditory organ than with the so-called mucous grooves.

The lateral regions of the skull behind the premaxillaries are formed, in front of the orbit, by the prefrontal and maxillary, and behind the orbit, first, by the maxilla and a large postorbital bone, then by the maxilla, by the bone marked P.O., which may very likely not be a true preoperculum, and a large supratemporal bone. The latter articulates above with the postfrontal and squamosal, and fits posteriorly into the notch formed by the vertical and horizontal portions of the bone P.O.

The operculum, a large four-sided bony plate, is connected with the outer edge of the epiotic above and with the posterior edge of the ascending ramus of the bone P.O. in front. Its lower edge articulates with the upper margin of the suboperculum, which is about half as large as the operculum, and has a much more rounded posterior edge.

The palato-quadrate arcade is best exhibited in fig. 1a, Plate I., though the lines of demarcation between its constituents are not

visible. Posteriorly, it is broad and expanded, furnishing the condyle to the mandibles by its outer and lower margin, while its upper and inner part probably abutted against the sphenoid. Anteriorly, it rapidly narrows, and is continued forwards as a strong bony bar. Running parallel with and outside this, is a second elongated bony ridge, which may be distinct from the foregoing, or may be only the outer part of it. At any rate, the two seem to become one in front. Here they support a very strong tooth, and there is a second large tooth situated far back upon the outer bone.

This palato-quadrate apparatus, taken altogether, very much resembles that of *Lepidosteus* in form, and in the large teeth which it bears.

The contour of the stout mandible follows that of the head, the gape extending as far back as the level of the posterior edges of the parietal bones. The rami are very stout, but appear to have consisted of only a thin osseous shell, sculptured externally in the same way as the cranial bones. The constituent elements of the mandible are not distinctly separated from one another in any specimen.

The jugular plates consist of two principal and a number of lateral scale-like bones. The former are elongated, nearly right-angled, triangles, with their perpendiculars turned towards one another, and their apices engaged in the re-entering angle of the rami, while their bases are situated midway between the articular ends of the rami and the posterior margins of the opercular apparatus. The peculiar sculpturing of these plates gave rise to the name of the genus, and is well shown in fig. 1c, Plate II. The outer edges of the principal jugular bones lie close to the inner edges of the rami of the mandible anteriorly, but posteriorly a space is left between them, which gradually widens posteriorly, and is so continued between the suboperculum and the posterior part of the principal jugular plate. This interval is filled up by the secondary jugular plates, of which, in one specimen, I count five, gradually increasing in size from before backwards. All these plates exhibit the characteristic surface ornamentation, and the last, much larger than any of the others, extends beyond the level of the posterior margin of the principal jugular plate, its curved free margin sweeping backwards and outwards, and lying between the suboperculum and the pectoral arch, while a considerable portion of the bone seems to pass under and be overlapped by the suboperculum. There is no median rhomboidal intercalary bone between the anterior and inner edges of the principal jugular bones.



The ventral part of the pectoral arch is represented, on each side, by two broad, triangular, somewhat curved, bones. The anterior one meets its fellow in the middle line, just behind the posterior edges of the principal jugular bones; but their inner margins immediately diverge, passing backwards and outwards, and being continued in the same direction as far as the posterior edge of the operculum, by the inner edge of the posterior pectoral plates. The adjacent margins of the two plates seem to be firmly united together, and their outer surfaces exhibit a marked sculpture, whose ridges are more evenly continuous than those of the cranial bones. Two large triangular scales which fit in between the supraoccipital and the epiotic appear to represent some of the upper elements of the pectoral arch.

The pectoral fins are not perfectly displayed in any specimen, but fig. 2, Plate II., shows that they were well developed, being about as long as the head, and that they were provided with numerous long and delicate fin rays which beset the edges and extremity of a stout central stem, covered with rhomboidal scales.

The ventral fins, smaller than the pectorals, were also, as figs. 2, 3, Plate I., show, distinctly lobate, their central stem being covered with rhomboidal scales and terminating in a point, at about the middle of the length of the fin.

The median fins present very distinct jointed fin-rays, and, as may be seen in fig. 1, Plate I., the scales of the body are continued on to the bases of the dorsals and anal, so as to give them, though to a far less degree, the lobate aspect of the pectorals and ventrals.

Both dorsals are pointed at their extremities, and somewhat fan-shaped, from being narrower at their bases than in their posterior moieties. The first dorsal is smaller than the second. The anal fin, opposite the second dorsal, is about as large as the latter, and has the same slightly lobate aspect.

The rhomboidal caudal fin, whose rays commence almost immediately behind those of the second dorsal and anal, is perfectly symmetrical, the axis of the tapering extremity of the body being not only free from any upward inflexion, but corresponding with the "equator" of the fin.

The scaly extremity of the body appears to stop at some distance before reaching the posterior margin of the fin, but it is difficult to make quite sure of the fact.

The scales are thin, and exhibit a sculpture of variable appearance, but always made up of raised ridges, with intervening valleys

and pits over the greater part of their surface; narrow smooth facets being left along two sides to receive the overlapping edges of other scales.

A single longitudinal row of hexagonal scales occupies the middle line of the back, and a less marked row of rhombic scales runs along the ventral median line. The lateral scales, rhomboidal in form, extend from the medio-dorsal to the medio-ventral series, forming curved rows transverse to the axis of the body in general direction, but presenting a marked concavity, or re-entering angle, forwards.

With respect to the dentition of *Glyptolæmus*, I find a series of minute pointed teeth along the outer margins of both upper and lower jaws. Besides these there is a single large tooth upon each side of the symphysis of the mandible, and at least one more of the same kind, a little in front of the middle of the ramus (fig. 1b, Plate II.) In the upper jaw, the pterygopalatine apparatus is, as I have already pointed out, provided with several similar teeth.

*Glyptolæmus* is at present only known to occur in the Old Red Sandstone of Dura Den.

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#### EXPLANATION OF PLATES I. AND II.

##### Plate I.

Fig. 1. Side view of a specimen of *Glyptolæmus Kinnairdi*, half the size of nature.

This and the other figures of the plate are taken from specimens in the Museum of Practical Geology.

Fig. 1a. Head of the same, natural size.

Fig. 2. Ventral and anal fins of another specimen.

Fig. 3. Ventral view of another specimen, half the natural size. Mus. Pract. Geol.

Fig. 4. Scales magnified.

##### Plate II.

The figures give various views of a specimen of *Glyptolæmus Kinnairdi* in the Museum of Practical Geology, and are all, except 3, 4, and 5, of the natural size.

Fig. 1. Dorsal view of the body.

Fig. 1a. Lateral view of the head.

Fig. 1b. Front view of the head.

Fig. 1c. Ventral view of the body.

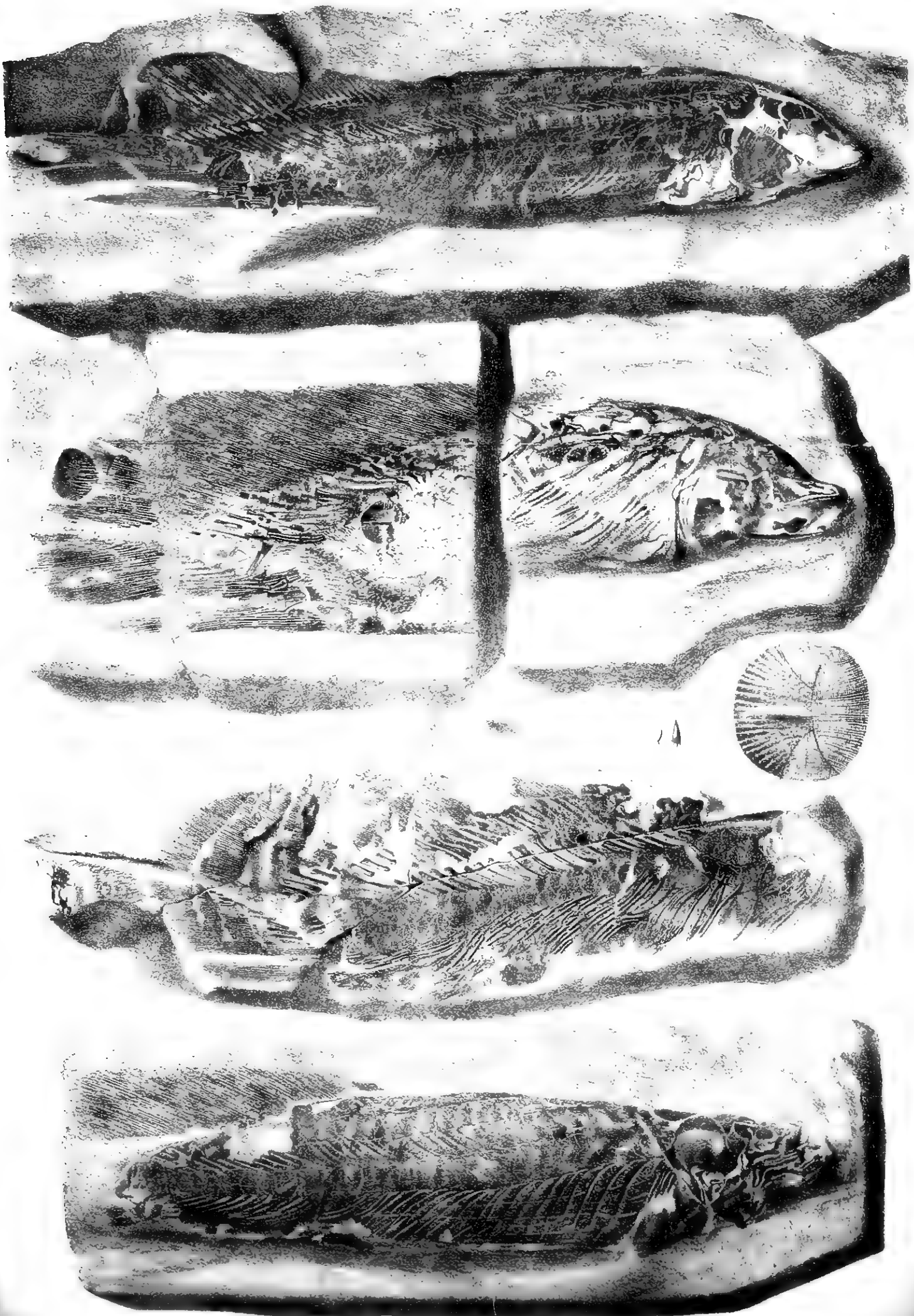
Fig. 2. Sandstone matrix into which the body fits, and which retains many of the dorsal scales and the pectoral fins.

Figs. 3, 4, and 5. Scales from different parts of the body magnified.

November 1, 1861.

T. H. HUXLEY.







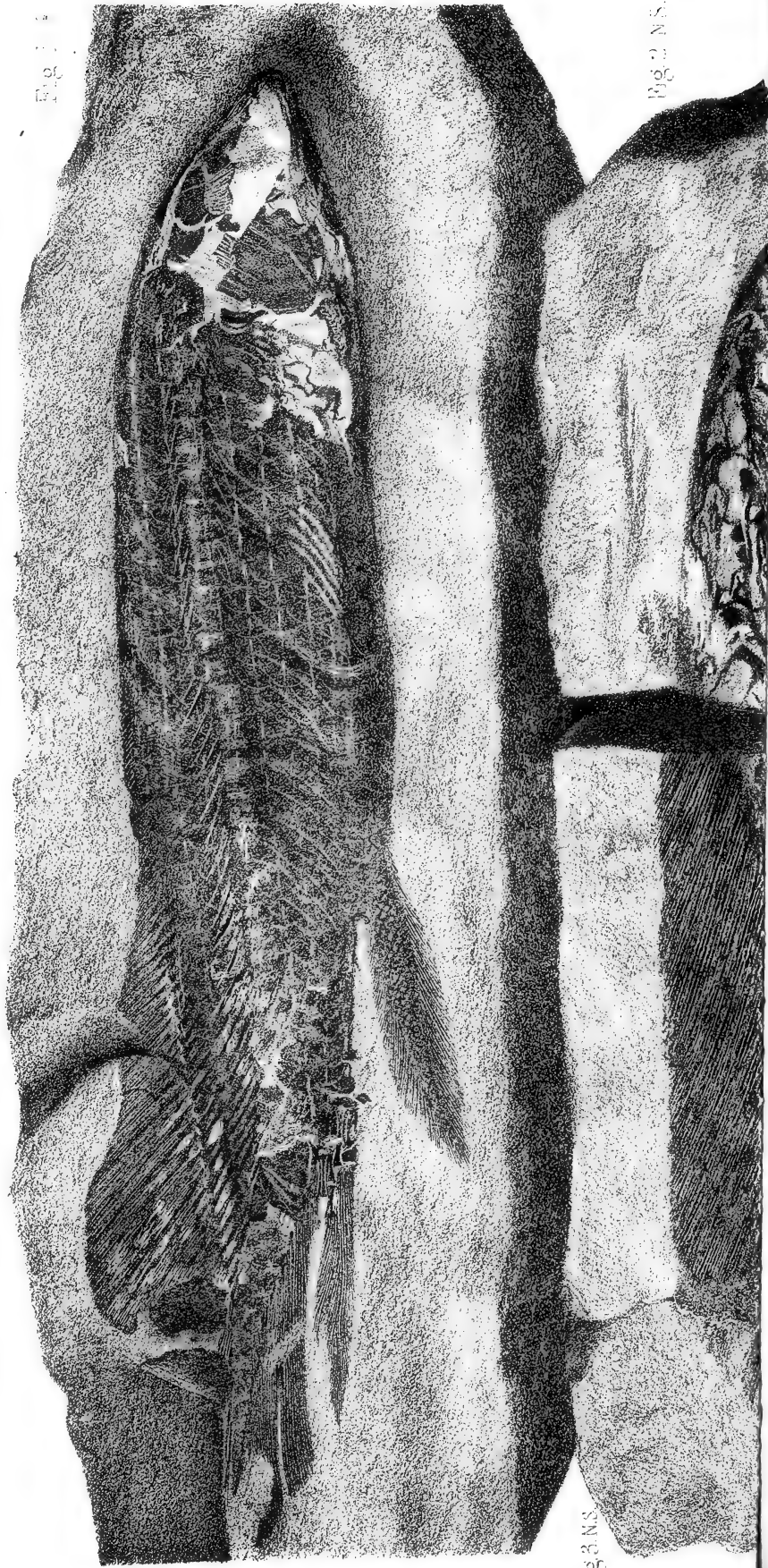


Fig. 1.

Fig. 2. N.S.

Fig. 3. N.S.

# BRITISH FOSSILS.

## DECADE X. PLATE III.

### PHANEROPLEURON ANDERSONI.

[Genus PHANEROPLEURON. HUXLEY. (Sub-kingdom Vertebrata. Class Pisces. Order Ganoidei. Sub-order Crossopterygidaë. Family Phaneropleurini.) Body elongated, tapering to an acute point posteriorly, compressed from side to side. Dorsal fin single, extending for nearly the length of the posterior half of the body; the paired fins acutely lobate; the ventrals very long, apparently longer than the pectorals, and situated beneath the anterior end of the dorsal fin. Tail inæquilobate, the upper lobe being by far the smaller. Scales cycloid, very thin. Teeth numerous and conical. Neural arches, ribs, and interspinous bones well ossified.]

*Phaneropleuron Andersoni.* SP. UNICA.

All the specimens of this species and genus at present known have been procured from the Old Red Sandstone at Dura Den, associated with *Holoptychius*, the two genera being constantly found associated in the same slabs of sandstone. A fine series of examples is to be seen in the British Museum and the Museum of Practical Geology, the whole of which, I believe, were collected by Dr. Anderson, in whose work upon Dura Den the first description of the present species appeared. The fish had received the name of *Glypticus* from Agassiz long before, but the name was unaccompanied by any description or definition, and has been used for a genus of Echinodermata. The most complete specimen I have seen is that figured (two-thirds of the natural size) in Plate III. fig. 1, which occurs among a number of other examples of this genus and of *Holoptychius*, in a fine slab marked 26120 in the collection of the British Museum.

The length of body equals about  $5\frac{1}{2}$  lengths of the head. It remains of tolerably equal thickness from the pectoral region to that of the ventral fins, and then gradually tapers off to a finely pointed caudal extremity, which is, usually, slightly bent upwards. When the mouth is shut, the head also presents a triangular contour, both its upper and its under outlines rapidly shelving towards the snout.

The scales are exceedingly thin, and, apparently in consequence of containing very little bony matter, they are apt to run into one



another and lose their distinctness when fossilized. But so far as the best preserved specimens enable me to judge they were large and circular, and their outer surfaces were marked by very slight and delicate, granular, radiating striæ, which may, however, be indications of internal structure and not of ornamentation (Pl. III. fig. 7). These differences from the scales of *Holoptychius* become particularly obvious when, as in the slab in the British Museum above referred to, specimens of the two genera lie side by side in the same matrix, or when, as in fig. 3, Plate III. detached scales of *Holoptychius* have become imbedded in the midst of a specimen of *Phaneropleuron*.

The cranial bones are smooth, or, at most, present irregular and scattered grooves. The cranium seems to have been much more compressed from side to side than in most Devonian fishes, but I can say little else respecting its structure, as it is much injured in all the specimens I have seen. In no specimen are the boundaries of the cranial bones defined. The operculum, however, is large. The orbit seems to have been situated far forwards, and the gape is long. Both the upper and the lower jaw are beset with a single series of sharp short conical teeth. One specimen on the slab 21620 in the British Museum, exhibits the only view of the under surface of the head I have met with, and proves that the jugular region was protected by bony plates. Whether there were more than the two principal ones, or not, however, I cannot make out with certainty.

The pectoral arch is well developed, but I can say nothing as to its individual components, nor are the pectoral fins thoroughly well preserved in any specimen. Such parts of them as exist lead me to the belief that they were shorter than the ventrals, but like them acutely lobate.

No pelvic bones are discernible, but the ventral fins are beautifully displayed in two examples on the slab 26120 in the British Museum, and in another specimen marked 26117 in the same collection.

Their length exceeds the greatest vertical diameter of the body. A taper central lobe extends through the whole length of the fin, ending in a point at its fine end. It is covered throughout with cycloid scales, having the same characters as those of the body, and both edges are fringed with delicate fin-rays.

The notochord was persistent throughout the whole length of the vertebral column, while the superior and inferior arches were well developed and thoroughly ossified.

The neural spines are long, and are curved, so as to be somewhat concave forwards and upwards. In the posterior moiety of the body, elongated interspinous bones, narrow in the middle and



expanded at the ends, are adapted to them. These interspinous bones increase in length from before backwards to beyond the middle of the dorsal fin, and support the fin-rays, whose bases are broad and solid, while they divide into a series of branchlets at their ends. There may be more than one fin-ray to each interspinous bone.

The dorsal fin, commencing with the posterior half of the body, gradually increases in height posteriorly, as its upper margin remains parallel with the axis of the body, while the dorsal line of the body converges towards that axis; the fin terminates posteriorly in an almost vertically truncated extremity.

The ribs attain a considerable length, even close to the head, and are continued through the whole length of the abdomen, passing gradually into the subcaudal bones. They are well ossified, and hence, in the fossil state, they stare through the thin integumentary scales of the fish so as to suggest its generic name.

The anal fin is somewhat lanceolate in shape, inclined downwards and backwards, and so long that its lower extremity is as distant from the axis of the body as the upper edge of the dorsal. It is supported by interspinous bones like those of the dorsal fin.

The inferior lobe of the caudal fin commences immediately behind the anal, and its rays appear to be supported by similar interspinous bones, at least anteriorly. It can be traced backwards to near the extreme end of the body. The superior lobe, on the other hand, seems to have been obsolete.

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#### EXPLANATION OF PLATE III.

Fig. 1. *Phaneropleuron Andersoni*, two-thirds of the natural size. From a specimen in the British Museum, No. 26120.

Fig. 2. Head of a specimen in the Museum of Practical Geology. The upper contour of the cranium seems to be slightly distorted. Natural size.

Fig. 3. Caudal extremity of a specimen in the British Museum, exhibiting the anal fin. A scale of *Holoptychius* lies above the end of the tail.

Fig. 4. Hinder part of the body, with ribs, neural arches, interspinous bones, and impression of the caudal part of the tapering notochord. In the Museum of Practical Geology.

Fig. 5. Head and body, with the opercular apparatus and impressions of the ribs and neural arches nearly undisturbed. In the Museum of Practical Geology.

Fig. 6. Teeth magnified.

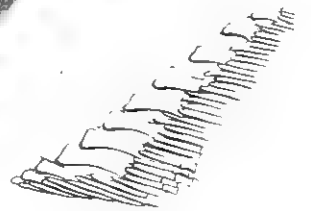
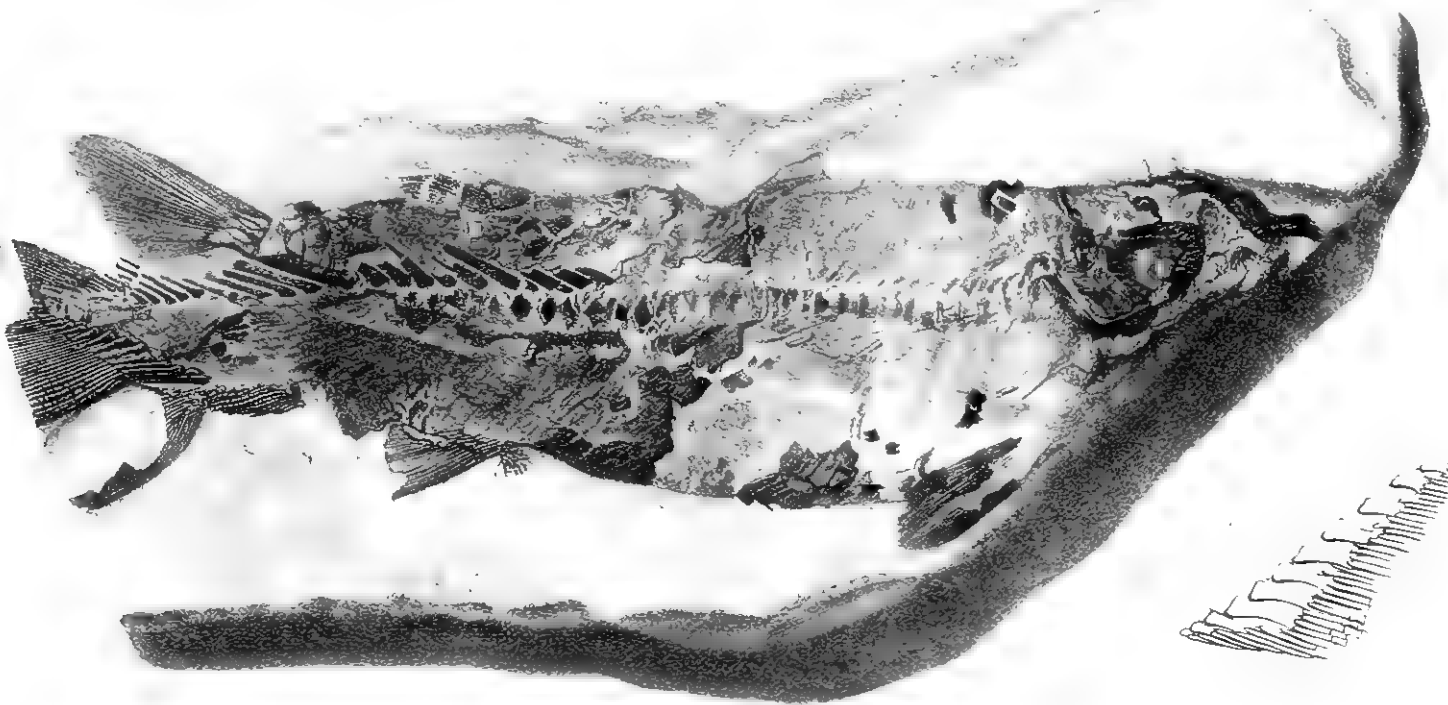
Fig. 7. A scale magnified.

T. H. HUXLEY.

*Jermyn Street, Nov. 1, 1861.*







TRISTICHOPTERUS ALATUS *Eaton*



1



TRISTICHOPTERUS ALATUS — *Egerton*.

# BRITISH FOSSILS.

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## DECADE X. PLATES IV. AND V.

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### TRISTICHOPTERUS ALATUS.

[Genus TRISTICHOPTERUS.\* EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Cœlacanthi.) Body fusiform. Cranial bones sculptured. Two dorsal fins; one anal fin; the rays of the second dorsal and the anal fin springing from three strong interspinous bones in each. Caudal fin springing from eight or nine similar bones. Vertebral centres ossified and prolonged through the upper lobe of the caudal fin.]

*Tristichopterus alatus.* SP. UNICA.

This is one of the many interesting additions made to the fossil Fauna of Scotland by the zeal and intelligence of Mr. Peach. Two specimens only have been obtained, one showing the general form of the fish, with the exception of the extremities of the head and tail, the other, with its counterpart, exhibiting in perfect preservation the structural and other characters of the fins and tail. The expanse of the latter and the opposition of the second dorsal to the anal fin are characters which might lead one to refer this form to the genera *Diplopterus* or *Gyroptychius*, but a rigid examination of the specimens convinces me that it formed a member of the Cœlacanthoid family, although presenting some important discrepancies from the other genera of that family. The points of resemblance are seen in the number and position of the fins, the curvilinear outline of the scales, and the prolongation of the central portion of the tail. The differences consist in the structural details of the fins and the ossification of the vertebral centres; but in these respects the deviation from the *Sauroides-dipterini* is quite as great as from the *Cœlacanthi*.

*Description.*—The more perfect of the two specimens measures seven and a half inches in length; if to this we add two and a

\* From τρεῖς tres, στίχη series, πτερόν ala.

quarter inches, the dimensions of the tail supplied by the second specimen, and three-quarters of an inch for the absent portion of the head, the entire length of the fish will be ten and a half inches. The depth at the greatest diameter is two inches. The body is irregularly fusiform, the dorsal line being less curved than the ventral outline, and the anterior half of the body more obtuse than the caudal portion. The bones of the head (with the exception of a small fragment of the operculum) are wanting, but the impressions distinctly left upon the matrix show that they were sculptured in rather a bold pattern, not unlike the ornament on the cranial bones of some of the *Holoptychii*, and consequently differing in this respect from the corresponding parts in *Dipterus*. The pectoral fins are very indistinctly seen. They appear to have had a short obtuse lobe forming the base, and extending therefrom a set of numerous fin-rays more elongated than those forming the pectoral fin in *Dipterus*. The small anterior dorsal fin is situated at the commencement of the last third of the body, and is opposed to the ventral fins. The latter are broad and composed of numerous rays expanding from a short lobate base. Both these and the pectoral fins differ from the corresponding organs in *Dipterus* in having more numerous and longer rays.

The structure of the other fins is very singular and requires a more detailed description. The second dorsal fin is placed immediately opposite the anal fin, and resembles it so closely that one description will serve for both. In each of these fins the component rays spring from three interspinous bones, and these are attached to a single broad spinous apophysis. The latter bone is probably a composite one, formed by the union of three or more spines. The interspinous osselets have cylindrical shafts expanded at each extremity, the one for attachment to the vertebral spine, the other for affording a base for the insertion of the fin-rays. In the anal fin the anterior bone of the triplet is shorter than the others and than the corresponding bone in the dorsal fin. The fin-rays springing from the first bone are the strongest. The anterior ones are the shortest and they lengthen in succession until the maximum extent of the fin is attained. They are single at first, but bifurcate in the distal part of the fin. The transverse joints are numerous. The group abutting upon the first interspinous bone contains about six rays. The second bone carries about eight rays, more slender than the former and more frequently subdivided. The anterior ray of this group is the longest, the subsequent ones decreasing in length in succession. The third



bone gives attachment to at least a dozen rays, finely fimbriated, and forming the posterior fan-like portion of the fin. The integuments extended over the interspinous bones as far as the commencement of the true fin-rays, thus forming the lobate base so characteristic of the fins in all the Cœlacanthoid fishes. The upper lobe of the tail contains numerous rays, the anterior ones being short and fulcral, forming a marginal fringe along the upper edge of the fin. A few of the upper fin-rays are given off from a set of short neurapophyses, but the terminal rays seem to abut upon the vertebral axis. This is prolonged through and beyond the caudal fin, and is furnished at its extremity with a few fine rays forming a kind of supplemental fin projecting beyond the terminal margin of the normal caudal fin. This peculiar form of tail is common to many of the Cœlacanthoid genera, and is most fully developed in the genus *Cœlacanthus* from the Permian and Carboniferous beds. It differs from the "diphycercal tail" of Prof. M'Coy, in which the upper and lower rays of the true caudal fin form the terminal point. This form is characteristic of the genera *Diplopterus* and *Gyroptychius* belonging to the *Sauroides-dipterini*. The lower lobe of the tail is constructed upon a plan similar to that above described as occurring in the second dorsal and anal fins, but the interapophyseal osselets are more numerous. They are eight or ten in number, and each carries four or five rays. These rays are stouter than those of the upper lobe and are more frequently jointed and subdivided; the rays, above the upper interapophysis, forming the central area of the tail, impinge upon the lower periphery of the vertebral column, and decrease successively in length so as to form a vertical termination to this lobe of the tail. The condition of the vertebral axis in this fish forms a remarkable exception to the general law hitherto applicable to the greater part (if not to all) the fishes of the Old Red Sandstone, and to all the *Cœlacanthi* hitherto described. If we except the genus *Dipterus* (some specimens of which show a tendency to ossification in the caudal region) all the Devonian genera have been considered *Notochordal* fishes, that is to say, the *chorda dorsalis* has persisted in its embryonic condition without any trace of segmentation. In the present subject, however, the whole of the vertebral axis has left its impression distinctly on the matrix in one specimen, and in the other the vertebræ of the caudal region are preserved entire. There can be no doubt entertained therefore that in this genus the ossification and segmentation of the column was complete, in which respects it stands alone among the contemporaneous fishes. The scales more nearly

resemble those of *Dipterus* than any other, but the surface ornament is differently arranged. The enlarged representations of two scales, one from the flank, the other from the lateral line, most carefully drawn by the skilful pencil of Mr. Dinkel, show the characters more clearly than any description can do. The posterior margins of the scales are all curvilinear, differing in this respect from *Gyroptychius*.\*

*Affinities*.—In assigning this new form to the Cœlacanthoid family, I have been mainly influenced by its resemblance in many respects to *Dipterus*. The latter genus was arranged by Professor Agassiz with the *Sauroidei-dipterini*, but I have long ago seen sufficient reasons for considering it a Cœlacanth, approximating more nearly to *Glyptolepis* and *Holoptychius* than to any other genera. Professor Pander, however, in his work on Fossil Ichthyology, a publication remarkable alike for the labour it evinces and the extraordinary beauty of the illustrations, has issued a monograph on the genus *Dipterus*, in which he disagrees with this arrangement (first published by Professor M'Coy), and seeks to establish a new family for its reception, which he designates "*Ctenodipterini*." Hugh Miller, so long ago as the year 1848,† made known the curious discovery that the fossil crania named by Professor Agassiz "*Polyphractus*," belonged to the genus *Dipterus*, and furthermore, that the palatal teeth called "*Ctenodus*" by the same author, constituted the dental apparatus of the same genus. Professor Pander seems to have arrived at the same conclusion in 1858, not being aware of the previous discoveries of Hugh Miller, whose claim to priority, however, he acknowledges in a postscript. At the same time, Hugh Miller exposed the fallacy of assigning two anal fins to *Dipterus*, proving the so-called anterior anal fin to be one of a pair of ventrals. Professor Pander entertains the same opinion, but does not allude to Hugh Miller's correction, nor does Professor M'Coy seem to have been aware of it, as he describes the genus as having two anals. The genera *Osteolepis*, *Diplopterus*, and *Glyptolepis* are also rightly deprived of the anterior anal fin in Professor Pander's publication. The term *Ctenodipterini* is intended to express the association of the dental apparatus called *Ctenodus* with the genus *Dipterus*, but it is an objectionable term, inasmuch as it

\* Professor M'Coy figures a scale (Plate 2 c. Fig. 2 a. British Palæozoic Fossils), which he describes as a scale from the back of *Gyroptychius angustus*. It very much resembles a scale of *Tristichopterus*.

† *Witness Newspaper*, December 23, 1848.

suggests the idea of a Dipterian fish with Ctenoid scales. If the family is proved to be well founded, the title *Otenodo-dipterini* would be preferable. The genera *Ceratodus* of Agassiz, and *Conchodus* and *Chirodus* of M'Coy are referred by Pander to this family. The absence of all evidence as to the dental apparatus of *Tristichopterus* is much to be regretted. On other points the affinities between this genus and *Dipterus* are so striking that they cannot be classified in separate families.

*Locality.*—At the meeting of the British Association at Aberdeen in 1858, Mr. Peach read a short notice of several new forms of fossil fishes discovered by himself in the north of Scotland. The subject of the present Memoir is thus alluded to: "The great interest attaching to the next arises from its having a short vertebral column running from head to tail, and also strong internal supports to the fin-rays. Whether these and the vertebral column are of bone is still an open question. The scales are large and coarse; it is about ten inches in length; and came from the red and blistered sandstones near John o'Groat's House." The second specimen, contributing materially to the knowledge of the genus, is not mentioned by Mr. Peach. Both these specimens now form part of the collection in the Museum of Practical Geology.

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EXPLANATION OF PLATES IV. AND V.

Plate IV.

- Fig. 1. *Tristichopterus alatus*, size of nature.  
 Fig. 2. Structure of the tail, magnified.

Plate V.

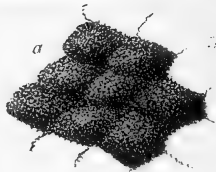
- Fig. 1. *Tristichopterus alatus*, size of nature.  
 Fig. 2. Scale of the flank, magnified.  
 Fig. 3. Scale from the lateral line, magnified.

P. DE M. GREY EGERTON.

Oulton Park, Nov. 15, 1860.







ACANTHODES PEACHI — *Egerton*

ACANTHODES CORIACEUS — *Egerton*.

# BRITISH FOSSILS.

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DECADE X. PLATE VI. Figs. 1 and 2.

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## ACANTHODES PEACHI.

[Genus ACANTHODES. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonialepidoti. Family Acanthodei.) Body fusiform. Mouth large, opening upwards. Orbits encircled by four bony plates. Branchiæ exposed. Fins membranous, supported by strong spines. One dorsal spine near the tail; one anal below and slightly in advance of the dorsal; pectoral spines strong; ventral spines small. Scales minute.]

The genus *Acanthodes* forms the subject of the first article in Professor Agassiz's volume on the Ganoid fishes. At that time only one species was known, *Acanthodes Bronni*, from the Coal-measures of Saarbrüch. Before the completion of the work, two others had been discovered, *Acanthodes sulcatus*, from the Coal-measures at Newhaven, and *Acanthodes pusillus* from the Old Red Sandstone near Gordon Castle. In the description of the latter species, in his later publication on the fishes of the Old Red Sandstone, Professor Agassiz supplements the characters of the genus given in the former work, with all the information derived from these subsequent discoveries. It was reserved, however, for Ferdinand von Römer, of Breslau, to complete the anatomical details of this singular fish, by the examination of hundreds of specimens (as he himself recounts) of a new species, *Acanthodes gracilis* (*Holacanthodes* of Beyrich), discovered in the Permian strata of Klein-Neundorf, near Löwenberg.\* Since the publication of this memoir (to which I must refer the reader for the many curious structural details therein described), the Old Red Sandstone of Scotland has contributed three additional species to this genus. These will be considered in this and the following chapter. Two of these novelties were discovered by Mr. Peach, and in recognition of the great services he

\* Ueber Fisch- und Pflanzen-führende Mergelschiefer des Rothliegenden bei Klein-Neundorf unweit Löwenberg, und im Besonderen über *Acanthodes gracilis* den am häufigsten in denselben vorkommenden Fisch.—Von Herrn Ferd. Roemer in Breslau, 1857.

has rendered to Palæontology I propose to designate the subject of this article by his name.

*Description.*—Although somewhat longer than the *Acanthodes pusillus* from Tynet Burn, this is, nevertheless, one of the smaller species of the genus. The length of the only specimen found in tolerable preservation is about  $2\frac{1}{10}$  inches. The depth of the the body is four-tenths, and caudal pedicle two-tenths of an inch. It differs remarkably from *Acanthodes pusillus* in these relative dimensions, being a thicker fish and less elegant in its proportions. The latter species is usually found doubled up upon itself, as if it had died a violent death. The Caithness species is also recurved, as if it had met with a similar fate; but, owing to the greater rigidity of the body, the distortion has been less excessive. The head seems to be large in proportion to the body, but this appearance may be due to the mutilated condition of this portion of the specimen. Owing to a forcible disruption of the integuments at the junction of the head and thorax, the former has been thrown up and crushed vertically, in consequence of which its natural proportions are disfigured by the lateral projection of the component bones. The pectoral fins remain in their proper position. They are supported by two strong spines, slightly recurved. The portions of the thoracic arch, to which these spines are attached, are seen sloping upwards from the articulation. They probably represent the coracoid bones. They are of slighter proportions than the corresponding bones in the genera *Cheiracanthus* and *Diplacanthus*. The ventral fins are situated about midway between the pectoral and anal fins. They are furnished with two spines, more slender than the other fin spines, but longer in proportion than in any other species of this genus. The dorsal fin is placed in a more forward position than the corresponding organ in the allied species. Instead of being slightly more remote than the anal fin, it is immediately above it. The spine which carries the fin is the strongest of the set. It is more curved than the dorsal spine of the other species of contemporaneous origin. The anal spine is also strong and curved. All the fin spines are ornamented with three or four longitudinal grooves. The tail is very broad for the size of the fish. The upper lobe projects beyond the lower lobe to a considerable extent, but does not taper off so gradually as in other species. The appearance of a bifurcation at the extremity is due to a separation of the integuments, either from pressure or decomposition. The scales are very minute, at the same time they appear to have been coarser than the scales of *Acanthodes pusillus*.



*Locality.*—This specimen was discovered by Mr. Peach about four years ago in a quarry of the Old Red Schist belonging to the Earl of Caithness, near Barragill. It is now in the Museum of Practical Geology in Jermyn Street.

PLATE VI. Figs. 3, 4, 5.

ACANTHODES CORIACEUS.

This singular little fish is another of the novelties produced at the Aberdeen meeting by Mr. Peach. It is not without hesitation that I refer it to the genus *Acanthodes*, but as the only alternative would be to establish a new generic definition, the preferable course, it appears to me, is the one thus adopted, since it is better to defer the introduction of a new title until good and sufficient materials substantiate its necessity, than to enter a new generic name on the list, already overcrowded, which may hereafter be found to be unnecessary.

*Description.*—The unique specimen of this fish discovered by Mr. Peach scarcely exceeds 1 inch in length. It reposes on the left side, having the ventral surface slightly upturned so as to display all the fins. It will be seen on referring to the enlarged representation most accurately delineated by the practiced and skilful hand of Mr. Dinkel, that the arrangement of the several fins is in close correspondence with the fin formula of the genus to which I have referred it. There are two pectoral fins, two ventral fins, one dorsal, and one anal fin, all armed with spines. The pectoral spines are the longest, and the ventral spines the shortest of the series. The dorsal and anal spines are intermediate in size, and both of the same length. The body of the fish is more slender and the fins more distant from each other than the corresponding parts of *Acanthodes Peachi*. The dorsal fin is also more remotely placed than in that species. These discrepancies forbid the idea I once entertained that it might possibly be the fry of that species. The most striking feature of this fish is the integumental covering. It has all the appearance of a thick corrugated skin, with here and there a trace of very minute scales. These are most evident near the caudal extremity, and a group of them from this spot has been carefully delineated by Mr. Dinkel. If the surface here seen be the true exterior layer, and not the result of decomposition, it would appear to be more granular than the coating of other Acanthodean scales.

*Locality.*—Mr. Peach found this specimen near Thurso, and described it as a smaller species than the preceding one “with strong and long spines, and as if clothed with a thick skin.” The specimens figured are in the collection of the Museum of Practical Geology.

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EXPLANATION OF PLATE VI.

- Fig. 1. *Acanthodes Peachi*, size of nature.  
Fig. 2.     “            “     enlarged once.  
Fig. 3. *Acanthodes coriaceus*, size of nature.  
Fig. 4.     “            “     enlarged twice.  
Fig. 5. Scales of ditto, greatly magnified.

P. DE M. GREY EGERTON.

*Oulton Park, Nov. 27, 1860.*





# BRITISH FOSSILS.

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## DECADE X. PLATE VII.

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### ACANTHODES MITCHELLI.

[Genus ACANTHODES. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Acanthodei.) Body fusiform. Mouth large, opening upwards. Orbits encircled by four bony plates. Branchiæ exposed. Fins membranous, supported by strong spines. One dorsal spine near the tail; one anal below and slightly in advance of the dorsal; pectoral spines strong; ventral spines small. Scales minute.]

SYNONYM. *Acanthodes antiquus*, EGERTON. Report of Brit. Assoc., 1859, p. 116.

At the meeting of the British Association for the Advancement of Science, held at Aberdeen in the month of September 1859, the Rev. Hugh Mitchell, of Craig near Montrose, communicated to the Geological Section a notice of the occurrence of fossil fishes in the Old Red Sandstone formation in Forfarshire. A cursory examination of the specimens exhibited in illustration of the memoir, satisfied me that the species discovered at Farnell were new to science, and I consequently named the subject of the present article *Acanthodes antiquus*. I subsequently saw two other new species of the same genus from the Old Red Sandstone of Scotland, and, therefore, cancelled the incorrect and objectionable specific affix, and substituted the name of the discoverer of this pretty and well characterized species.

*Description.*—The specimens I have examined of this pretty little fish vary from two inches to two and three-quarters of an inch in length. The one I have selected in illustration of this Memoir measures two inches and a half. The deepest part of the body (Pl. VII., fig. 2.) is at a point midway between the pectoral and the ventral fins. It here measures half an inch. The head measures about one-fifth

of the entire length. The cranial bones are gracefully sculptured with deep sinuous lines. The orbit occupies an advanced position, and is embraced by a set of the singular orbital plates first noticed and described by Ferd. Römer as characteristic of the genus *Acanthodes*. The branchial apparatus also corresponds with that of the other members of the genus. The outline of the body is remarkably graceful. It is fusiform anteriorly, and tapers gradually posteriorly to the base of the caudal fin. The latter organ is highly heterocercal, although the upper member is not so much extended as the corresponding part in the genus *Climatius*. All the other fins are supported by stiff spines. The pectoral spines are long and curved, the other fin spines are more slender and straight. The ventral fins are situated nearer to the anal than to the pectoral fins, and the dorsal spine is slightly nearer the tail than the anal fin. The species differs from its congeners in having the cranial bones more deeply sculptured, and in the form and position of the fin spines. It is most nearly allied to *Acanthodes Peachi*, but it differs from this species in the form of the body, in having the pectoral spines more curved, and the other spines straight, and in the more remote position of the dorsal fin.

*Locality*.—The deposit which has yielded this and the following interesting additions to the Fauna of the Old Red Sandstone of Scotland, is situated on the south-east bank of the Pow burn about half a mile south-west of the Farnell station on the Scottish North-Eastern Railway. It is described by Mr. Powrie as consisting mostly of fine grayish argillaceous shales, the lower beds splitting into fine laminæ nearly as thin as writing paper, and, when first opened, of a delicate cream colour. In a subsequent part of the paper the author says, “no painting could equal the beautiful appearance “ some of the smaller fishes exhibit when the little slab in which “ they have been entombed is first opened up, and still damp.” The Rev. Henry Brewster of Farnell was the first to discover the fossiliferous character of these shales, but the Rev. Hugh Mitchell of Craig first ascertained the association of fishes with the organisms previously discovered, and called attention to the subject in a paper he communicated to the Geological Section of the British Association at the Aberdeen meeting in 1859. Through the liberality of Lord Southesk, to whom the quarry belongs, every facility has been afforded for exploring its contents, and the zealous labours of Mr. Powrie and the Rev. Henry Brewster have added considerably to the stock of materials collected by the Rev. Hugh Mitchell. I am

indebted to all these gentlemen for the generous confidence with which they have entrusted to me the fragile treasures of their several museums, although well aware of the risk of injury to which they must be submitted in travelling from one extremity of the kingdom to the other.

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EXPLANATION OF PLATE VII.

Fig. 1. Outline of *Acanthodes Mitchellii*, size of nature.

Fig. 2. The same drawn in detail, twice the size of nature.

Fig. 3. Scales highly magnified.

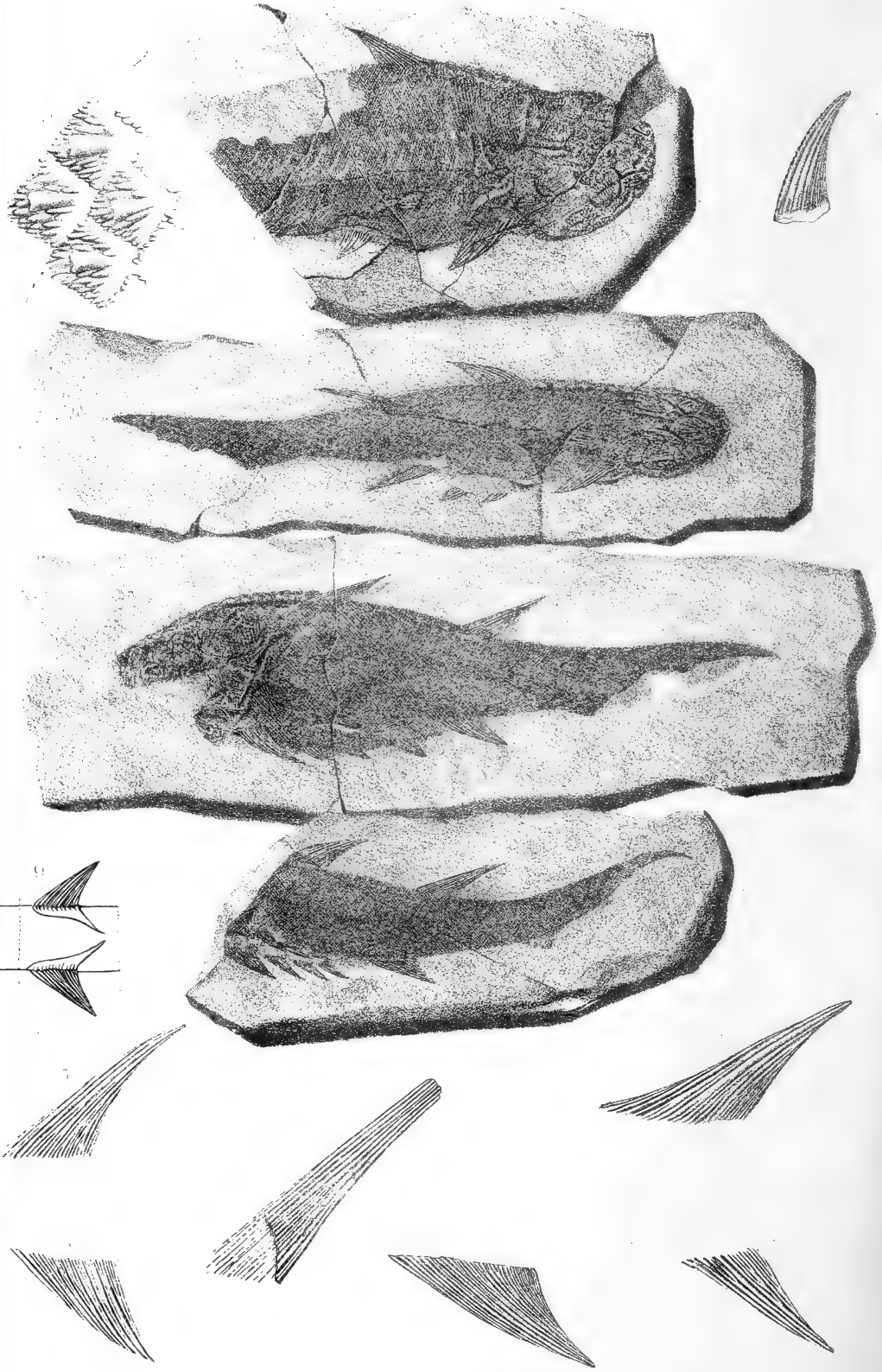
P. DE M. GREY EGERTON.

*Oulton Park, December 1860.*









CLIMATEUS SCUTLER *Synodon*  
 RETICULATUS *Arassii*

# BRITISH FOSSILS.

## DECADE X. PLATE VIII.

### CLIMATIUS SCUTIGER.

[CLIMATIUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniop-  
lepidoti. Family Acanthodei.) Body more or less fusiform. Tail heterocercal, attenuated.  
Fins membranous, supported by strong conical spines, striated longitudinally. Two dorsal  
spines; one anal spine; two pectoral spines; and two ventral spines. Three dermal  
spines on either side, between the pectoral and ventral fins. Dorsal ridge invested with  
large scutes.]

SYNONYMS.—*Brachyacanthus scutiger*. EGERTON, Report of Brit.  
Assoc. 1859, p. 116. *Ictinocephalus granulatus*. PAGE, Report of Brit.  
Assoc. 1858, p. 105.

The collection of specimens from the Farnell deposit, exhibited by the Rev. Hugh Mitchell at Aberdeen in 1859, contained, in addition to the *Acanthodes*, described in the preceding Memoir, several fragments of a small fish having considerable resemblance to the genus *Diplacanthus*. A closer examination of the best preserved specimen revealed, however, so many important points of difference that I was induced to assign to it a new generic title. The singularly short and massive character of the spines supporting the fins suggested the name *Brachyacanthus*. I have since found in Professor Agassiz's "Poissons Fossiles du Vieux Grès Rouge," the representation of a spine found at Balruddery, and described as a Placoid Ichthyodorulite, under the name of *Climatius reticulatus*, which I have no hesitation in identifying as belonging to a species of the Acanthodean genus under notice, although specifically distinct from the Farnell specimens. The name *Brachyacanthus* must consequently give way to the prior title *Climatius*.

*Description*.—The interest excited by the exhibition of these beautiful ichthyolites at the Aberdeen meeting gave such an impetus to the exertions of the explorers of the Farnell deposits that abundant materials shortly repaid their labours, not only for the full elucidation of the genus under notice, but for completing the

knowledge of several other associated forms. Through the kindness of Mr. Powrie, the Rev. Hugh Mitchell, and the Rev. Henry Brewster, I have been enabled to examine the most perfect specimens hitherto discovered, and from these materials the following description of *Climatus scutigera* is derived. The specimens comprise two forms, the one of more slender proportions than the other. In the absence of more important differential features, it would be impolitic to attach specific value to a discrepancy of this kind; it may be due to casual or local influences, or be a sexual character. It suffices for the present to notice the fact, leaving the question of specific value to be settled by future investigation. The specimens range from one inch and a half to two inches in length, from the snout to the base of the tail. The latter organ is rarely preserved entire, in consequence of its extreme tenuity and delicate structure, and the fragile texture of the shale in which the specimens are imbedded; but I am informed by Mr. Powrie, who had the advantage of seeing the specimens when first uncovered, that the upper lobe of the tail measures about one-third of the total length of the fish. This measurement would give about three inches as the extreme length of a full grown individual. The form and proportions of the head closely resemble those of the head of *Acanthodes*. As in that genus, the surface of the cranial bones is richly chased, but the sculpturing, instead of being continuous in vermicular gyrations, is more isolated, so as to give the appearance of a repetition rather than a continuation of the pattern. The fins are all supported by strong conical spines, or rather spurs. They correspond in number with those of *Diplacanthus*, namely, two pectoral, two ventral, two dorsal, and one anal. They are all grooved longitudinally, the ridges between the grooves being slightly crenulated, as in *Otenacanthus*. A few transverse lines (indicating, perhaps, periods of growth) occur near the base of the spines, crossing the longitudinal pattern, and causing the reticulate character which suggested the specific designation for the Balrudery spine described by Professor Agassiz. The pectoral spines are nearly as broad as long, short, and recurved. They are so firmly attached to strong coracoids that the latter appear to be integral portions of the base of the spines. The pectoral spines are easily distinguished from the other fin spines by the arrangement of the superficial pattern. In these the ridges run parallel with the posterior margin, whereas in the dorsal and anal fins they coincide with the anterior curve of the spine. The ventral spines are small; they are situated far back, in close proximity to the anal fin. The

interspace between the pectoral and ventral fins is armed with three pairs of defensive spines, similar in character to, but somewhat smaller than, the ventral spines. Properly speaking, they are elongated scutes, forming part of the dermal envelope. They have a shallow cavity where attached to the integuments, and the cast of this depression when the spine is removed much resembles a broad scale. The great development of this cutaneous armature has suggested the specific affix I have given to this fish. Some other genera of Acanthodeans show a tendency to this character; for instance, Professor Agassiz describes the occurrence of two small ventral spines, situated between the pectoral and ventral fins, in *Diplacanthus crassispinus*, and some specimens of *Acanthodes Mitchelli* have faint traces of the same peculiarity. The anterior dorsal spine is inserted over the central pair of ventral scutes, or nearly midway between the pectoral and ventral fins. It is larger than the pectoral spine, and slopes backwards at a considerable angle. The spine figured by Professor Agassiz in the "Poissons Fossiles du Vieux Grès Rouge," plate 32, fig. 25, is probably the anterior dorsal spine of his species. The great inclination of the spine suggested the generic title *Climatius*. The second dorsal spine is longer, straighter, and more slender than its companions. The anterior margin is quite straight, but the hinder limb bulges out about midway between the apex and the base. The anal spine is situated slightly in advance of the base of the second dorsal spine. It is intermediate, both in size and character, between the two dorsal spines, being longer and straighter than the one, but shorter and more bent than the other. Some specimens retain faint traces of the organs attached to these spines. There is a doubt whether they were composed of true fin rays or not. My own opinion is that they were membranous, as in the other genera of Acanthodean fishes, and that the appearance of striæ is to be attributed to the impression of the longitudinal series of minute scales with which they were invested. I have already alluded to the extraordinary development of certain scales on the ventral surface of the body. A repetition of the same character, although not to the same extent, occurs on the dorsal ridge, the interval between the occiput and the first dorsal fin being roofed by a single row of umbonated scales, not unlike those occurring in the genera *Saurorhamphus*, *Eurypholis*, and *Dercetis*, although not so large in proportion to the dimensions of the fish. The scales on the other parts of the body are very minute, and resemble those of the other Acanthodean fishes in form and arrangement. The

sculpturing of the surface is shown in the enlarged figure on the plate. The course of the lateral line is seen in some of the specimens. It runs along the flank about mid-distance between the dorsal and ventral margins.

I have recently received some spines from the Farnell beds, which correspond both in size and character with the specimens figured by Agassiz from Balruddery. They leave no doubt in my mind but that they are distinct from the species I have described; I therefore retain the specific name *C. scutigera* for the small species, leaving the Agassizian name for the larger species, but removing it from the Placoid order to the Acanthodean family of the Ganoids.

*Locality.*—All the best specimens I have examined of this fish are from the Farnell locality, where it appears to be one of the most abundant fossils. I am informed, however, by the Rev. Hugh Mitchell that it has also been found by him at Caunterland, in the parish of St. Cyrus; and at Tealing, five miles to the north of Dundee, by Mr. Walter McNicol.

#### EXPLANATION OF PLATE VIII.

Fig. 1. *Climatius scutigera*, from Mr. Mitchell's original specimen.

Fig. 2. Ditto, belonging to Mr. Powrie.

Fig. 3. Ditto, ditto.

Fig. 4. Ditto, belonging to Mr. Brewster.

These four figures are twice the size of nature.

Fig. 5. *Climatius scutigera*. 1st dorsal spine.

Fig. 6. Ditto. Pectoral spine.

Fig. 7. Ditto. Anal spine.

Fig. 8. Ditto. 2nd dorsal spine.

Fig. 9. Ditto. Pectoral spines and attachments.

These five figures are four times the size of nature.

Fig. 10. *Climatius scutigera*. Scales highly magnified.

Fig. 11. *Climatius reticulatus*. 1st dorsal spine from Agassiz's "Poissons Fossiles du Vieux Grès Rouge," pl. 33, fig. 25.

Fig. 12. *Climatius reticulatus*. 2nd dorsal spine from Farnell.

Fig. 13. Ditto. Pectoral spine from Farnell.

The last three figures are the size of nature.

P. DE M. GREY EGERTON.

Oulton Park, December 1860.





BRACHIOPODUS CRACILUS. *Pl. 11.*



# BRITISH FOSSILS.

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## DECADE X. PLATE IX.

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### DIPLACANTHUS GRACILIS.

[Genus *DIPLACANTHUS*. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Acanthodei.) Body fusiform. Tail heterocercal. Fins membranous, each supported by a spine. Two dorsal fins, one anal fin, two pectoral fins, and two ventral fins. Mouth large. Teeth conical.]

The genus *Diplacanthus* comprises a greater number of species than any other Acanthodean genus, at the same time it does not appear to have been nearly so numerous in individuals as the allied genus *Cheiracanthus*. Professor Agassiz has described four species, viz., *Diplacanthus striatus* from Cromartie, *Diplacanthus striatulus* from Lethen, *Diplacanthus longispinus* from both the above-mentioned localities, and *Diplacanthus crassispinus* from Caithness and Orkney. To these Professor M'Coy has added two species from the latter locality, viz., *Diplacanthus gibbus* and *Diplacanthus perarmatus*. The newly-discovered ichthyolitic deposit of Farnell has supplied a seventh species, which I proceed to describe.

*Description.*—The only specimen I have yet seen of this species belongs to the Rev. Henry Brewster of Farnell, and was forwarded to me with many other interesting specimens by Mr. Powrie of Reswallie, Forfar. It is in excellent preservation with the exception of the extremity of the tail, which is wanting. It measures four inches in length by three-quarters of an inch in depth. Were the specimen entire, it would probably be half an inch longer. On comparing these dimensions with those of the other species, it appears that the proportion of the depth to the length is considerably less in the species under consideration. *Diplacanthus striatulus* is in this respect most like *Diplacanthus*

*gracilis*, but the difference of the depth to the length in an individual of similar length, namely four inches, would be a quarter of an inch in excess. In consequence of this striking feature the Farnell *Diplacanthus* is at once recognized by its slender form and elegant proportions. The head is small, but remarkable for the large size of the oral aperture. The dentigerous bones, from the posterior angle of the mouth to the snout, measure three quarters of an inch. They seem to have been armed with a single row of conical teeth, the impressions of which are discernible, although rather indistinct. In this character the genus *Diplacanthus* resembles *Cheiracanthus* and *Cheirolepis*, and departs from *Acanthodes*. The orbit is placed well forward, and rather high in the skull. The arrangement of the opercular bones and branchiostegous rays corresponds with that of the homologous parts in the genus *Cheiracanthus*. The pectoral spine on either side is attached to a strong coracoid bone, having a straight styliform shaft, and an expanded base. The spines themselves are long, straight, and slender. The ventral spines are about half the length of the pectoral spines, and slender in proportion. They are situated nearer to the anal fin than to the thoracic arch. The position of the first dorsal spine is the most distinctive feature of the species. In all the other *Diplacanthus* it is inserted immediately behind the supraoccipital process, nearly above the base of the pectoral fins, and is the strongest spine of the series, whereas in this species it is situated midway between the occiput and the second dorsal spine, over the interspace between the pectoral and ventral fins. It is also smaller than the second dorsal and anal spines. These characters may hereafter prove of generic value. The second dorsal spine occupies its normal place immediately opposite the anal spine. It is quite straight and much longer than the first dorsal spine. The anal spine resembles it in all respects except in size, in which it is rather inferior. All these spines are straighter and slighter than the fin defences of the allied species. The base of the caudal fin is large, the lower lobe rounded posteriorly, and the fin broad. The upper lobe is deficient; some traces remain of the endoskeleton in the preservation of the superior spinous processes of the anterior portion of the vertebral column, which seem to have been partially if not wholly ossified. The scales are minute, having a rhomboidal outline and a granular surface.

*Locality*.—The specimen figured was found in the Farnell beds, associated with *Acanthodes Mitchellii*, *Climatius reticulatus* and

*scutiger*, *Parexus recurvus*, and other fossils characteristic of the Old Red Sandstone of that locality.

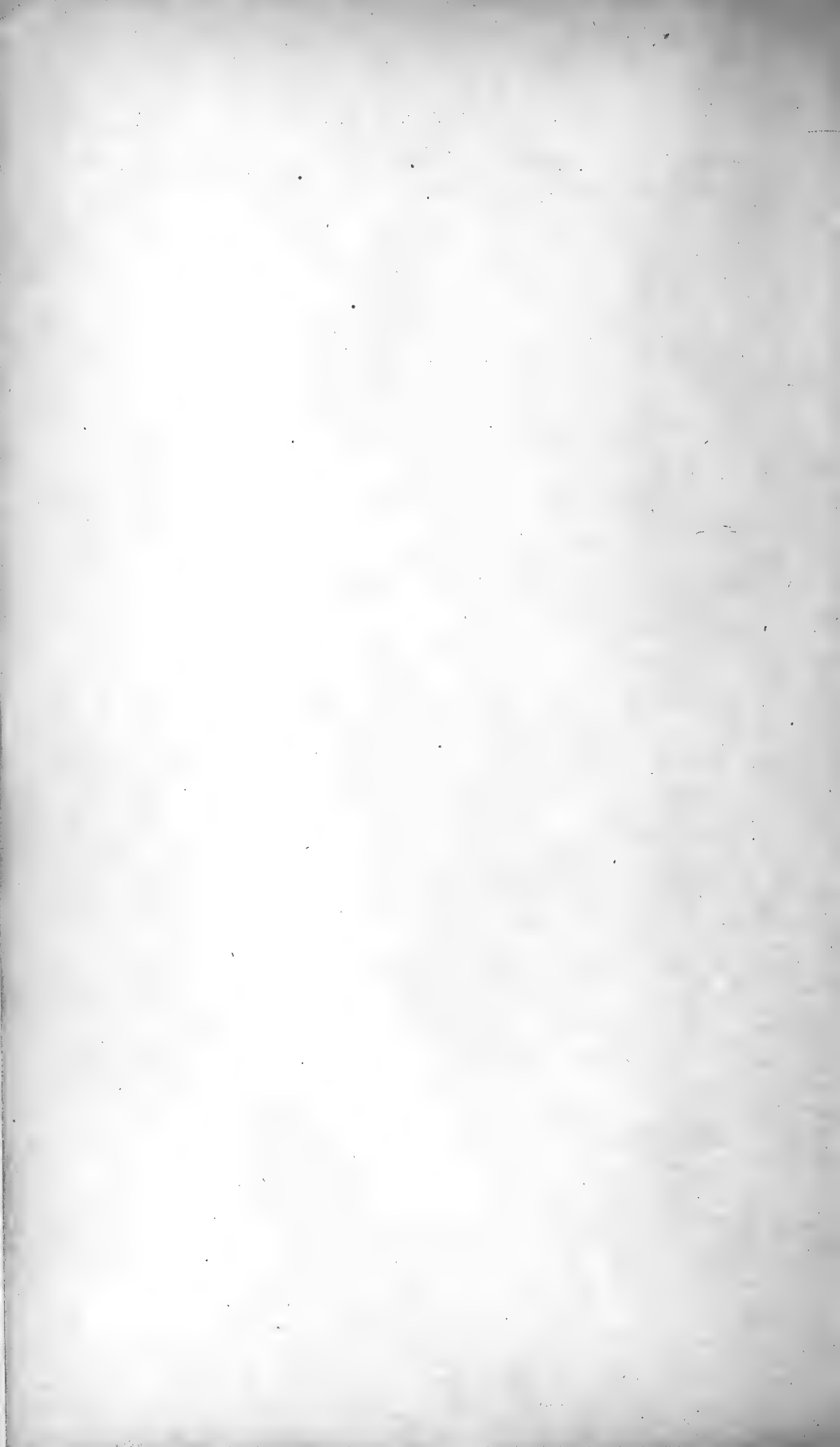
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## EXPLANATION OF PLATE IX.

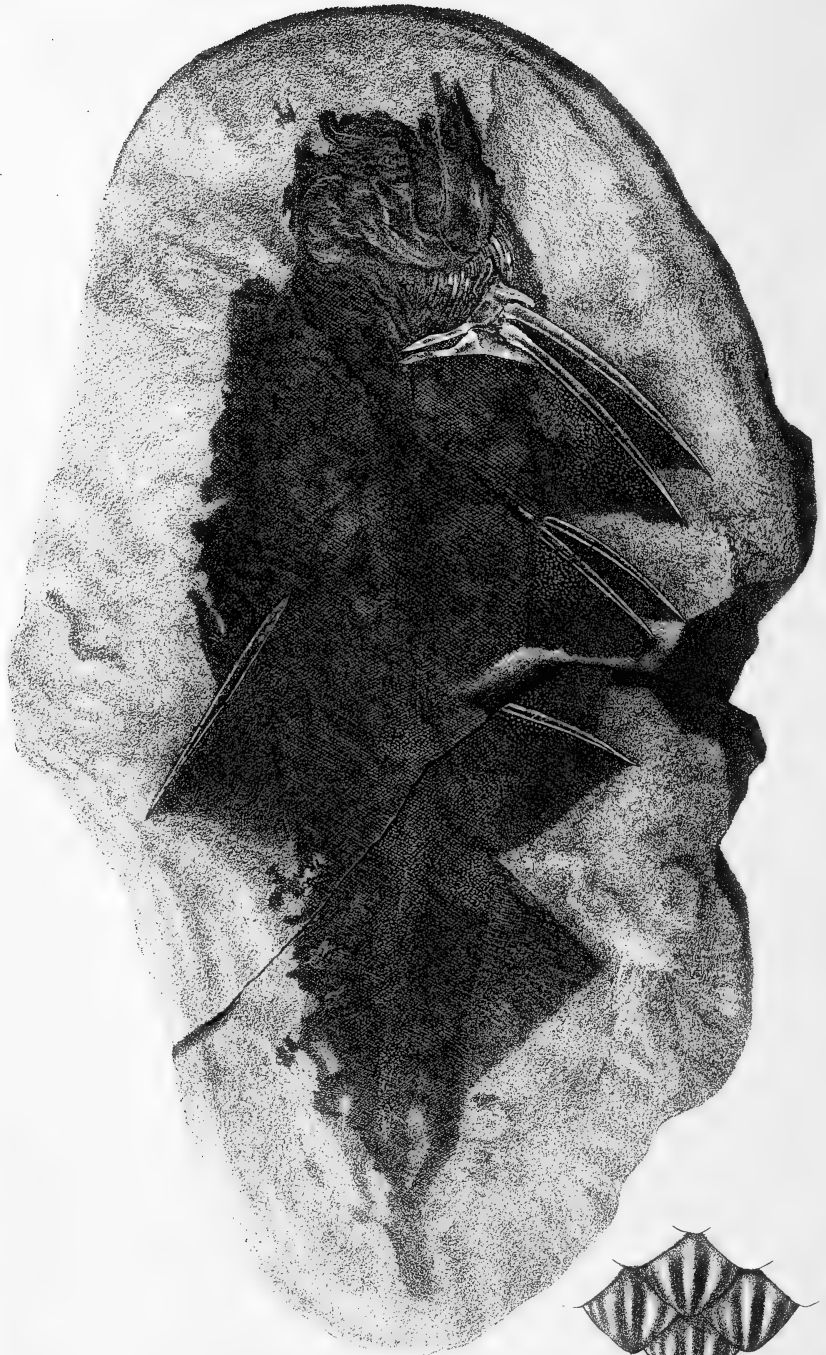
- Fig. 1. *Diplacanthus gracilis*, belonging to Mr. Brewster.  
Fig. 2. Scales highly magnified.

P. DE M. GREY EGERTON.

*Oulton Park, January 1861.*







CHEIRACANTHUS LATUS --- Egerton.

# BRITISH FOSSILS.

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## DECADE X. PLATE X.

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### CHEIRACANTHUS LATUS.

[Genus CHEIRACANTHUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Acanthodei.) Body fusiform. Tail heterocercal. Fins membranous, each supported by a strong spine. One dorsal fin, one anal fin, two pectoral fins, and two ventral fins. The dorsal spine situated above the interspace between the ventral and anal fins. Pectoral spines articulated to two strong coracoid bones. Scales minute. Teeth small, conical.]

The generic characters of *Cheiracanthus* are so clearly defined by Professor Agassiz in the "Poissons Fossiles du Vieux Grès Rouge," and the differences between this and the other Acanthodean genera so fully elucidated, that neither amendments nor additions are required notwithstanding the rapid progress of discovery since the publication of this standard work. Three species are therein described, *Cheiracanthus Murchisoni* from Gamrie, *Cheiracanthus microlepidotus* from Lethen and Cromartie, and *Cheiracanthus minor* from Orkney. Professor M'Coy has since described two species, *Cheiracanthus pulverulentus* and *Cheiracanthus grandispinus*, both from Orkney, the latter being the largest and most striking species of the genus. In consequence of the stimulus given to the exploration of the Old Red Sandstone deposits of Scotland by the meeting of the British Association at Aberdeen in September 1859, localities which had been previously but slightly examined were opened up, and yielded a rich harvest to the scientific labourers in Palæontology. Amongst others, the quarries at Tynet Burn were extensively explored through the liberality of the late Duke of Richmond, who employed a gang of workmen expressly for the purpose. Some of the best specimens discovered were forwarded to me by his Grace for examination, and amongst other novelties and many well-known species, I detected a new species of *Cheiracanthus*, which I have named *Cheiracanthus latus*.

*Description.*—On separating all the specimens of *Cheiracanthus* from the other genera with which they were associated it was evident that they indicated two distinct forms, one with a long tapering body and the fins rather distant from each other, the other short and thick, and having the fins closely approximated. The former is probably identical with *Cheiracanthus microlepidotus*, so common at Lethen; the latter I consider to be new. Both species appear to have been very abundant in the Tynet locality and to have been gregarious, but *Cheiracanthus latus* seems to have been most numerous. The collection forwarded to me contained above fifty examples, more or less perfect, of this fish. The length of an average-sized specimen is about six inches from the nose to the extremity of the tail, and the depth in front of the ventral fins one inch and a half, being an excess of one quarter of an inch as compared with a specimen of *Cheiracanthus microlepidotus* of similar length. The head is seen in profile, and measures an inch and a quarter in length from the point of the lower jaw to the posterior edge of the operculum. The mouth is large and horizontal; the teeth are not preserved in any of the specimens. Judging from the character of the dentigerous bones they were probably small and in single rows. The branchiostegous rays are very numerous, and extend high up in the opercular space. They are composed of a harder substance than the surrounding parts, being almost as dense as the fin spines, and are consequently preserved in most of the specimens. The pectoral fins are large and triangular. They are supported by a pair of strong spines, slightly curved and measuring one inch and a quarter in length. These are attached to a pair of coracoid bones, broad at the point of articulation and tapering upwards. A short process extends downwards from the same point on either side, meeting its fellow in the median line, and completing the thoracic arch. The large expanse of the pectoral fins required a powerful fulcrum such as this to enable them to fulfil their functions. The ventral fins are situated midway between the pectoral and anal fins. The spines supporting them are straight, and have their bases inserted in the integuments without any trace of pelvic bones. The dorsal fin occupies the middle of the back, the point of insertion of the dorsal spine being opposite the interspace between the ventral and anal fins. It is a large triangular fin attached to a long and straight spine deeply implanted in the muscular tissue. The anal fin spine occurs midway between the ventral spines and the base of the caudal fin, the membranous portion extending as far as the anterior margin of the latter organ.



The pedicle of the tail is very deep, and terminates in a broad fin, of which the upper lobe greatly exceeds the lower lobe in extent. The scales are smooth, umbonated below, and neatly sculptured on the outer surface with four or five parallel grooves. They are of uniform size over the entire body. The broad tail, large fins, and close arrangement of these on the ventral surface distinguish this species from all those hitherto described.

*Locality.*—All the specimens I have seen of this species are from Tynet Burn, where they occur in nodules similar to those found in the contemporaneous deposit at Lethen Bar.

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EXPLANATION OF PLATE X.

Fig. 1. *Cheiracanthus latus*. Size of nature.

Fig. 2. Scales magnified.

P. DE M. GREY EGERTON.

*Oulton Park, November 1860.*





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MEMOIRS  
OF THE  
GEOLOGICAL SURVEY  
OF  
THE UNITED KINGDOM.

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Figures and Descriptions

ILLUSTRATIVE OF
BRITISH ORGANIC REMAINS.

—
DECADE XI.

—
TRILOBITES.

(CHIEFLY SILURIAN.)
~~~~~

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## P R E F A C E.

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THE plates of this Decade were engraved a year ago, but the pressure of other duties compelled Mr. Salter, the late Palæontologist of the Geological Survey, to postpone the descriptions. That gentleman has now completed the work at my request, he being at present engaged on a Monograph of all the British Trilobites for the Palæontographical Society.

Following our usual plan, those genera only have been illustrated which are rich in material for the engraver, or those which, though less perfect, are so rare and interesting as to render it desirable to publish them, even from fragmentary materials. The genus *Olenus*, characteristic of the lowest Silurian rocks of all the northern parts of Europe, is an instance in point. All the British species, save one or two, are fragmentary, but these fragments illustrate several of the important sub-genera into which this genus of the primordial Silurian of Barrande is divisible; hence a second plate of it is given. *Æglina*, pl. IV., is another case of the same kind. The genus was previously illustrated in Decade 7, from imperfect pieces of the head and body. We now possess the entire form of this genus, which is eminently Lower Silurian in its range.

The genera *Stygina*, *Salteria*, *Trimeroccephalus*, *Angelina*, *Agnostus*, and *Stavrocephalus* have not before been illustrated in the Decades. *Asaphus*, before given in Decade 2 as to one of its sub-generic groups, now presents us with a British type of the sub-genus *Isotelus*, which is so common in America, but rare in Europe. Lastly, a fresh discovery, by the author of this Decade, of a gigantic *Paradoxides* in the Lingula flags of Pembrokeshire, has made it possible to figure this characteristic genus from perfect materials.

RODERICK I. MURCHISON,  
*Director-General.*

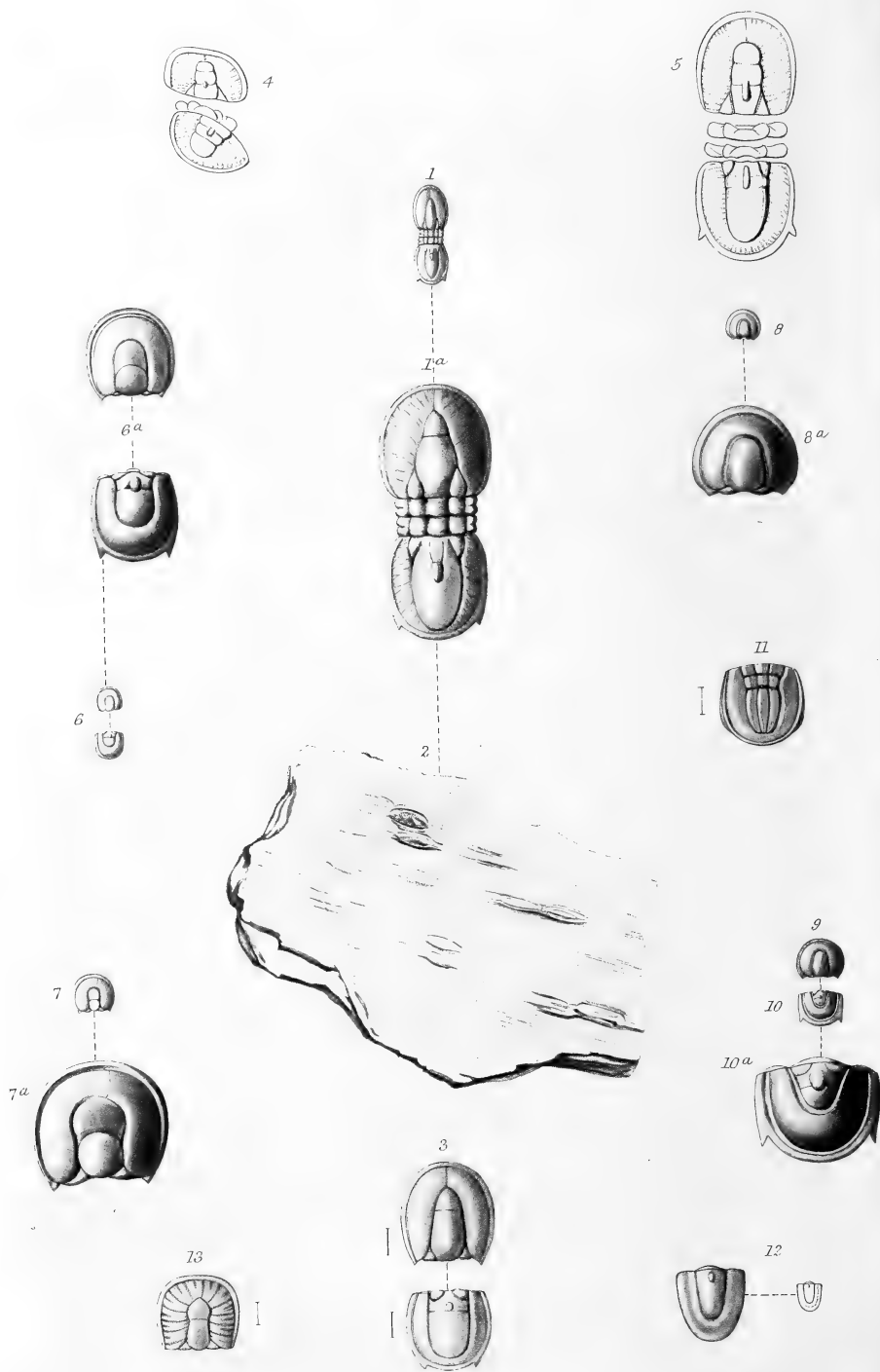
*Geological Survey Office,*  
28, *Jermyn Street, London,*  
November 1864.

#### NOTE.

The reader must understand that the numerous references to *Memoirs Geol. Survey*, vol. iii. (ined.) throughout this Decade apply to the forthcoming Memoir on the "Geology of North Wales," by Professor Ramsay; with an Appendix on the Fossils by Mr. J. W. Salter.







Figs. 1-5. AGNOSTUS PRINCEPS, Salter.

Fig. 11 AGNOSTUS TRISECTUS, Salter.

6-7. ——— Mc COYII, *id.*

12 ——— SP.

8-10. ——— TRINODUS, *id.*

13 ——— MOREA, *id.*

# BRITISH FOSSILS.

DECADE XI. PLATE I. FIGS. 1—5.

## AGNOSTUS PRINCEPS.

[Genus AGNOSTUS. BRONGNIART. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Agnostidæ.) Minute trilobites, with caudal and cephalic shields nearly equal. No eyes, no facial suture. Two body rings.—Ranges from Lingula flags to Caradoc rocks.]

DIAGNOSIS. *A. latus*, 7 lineas longus, scutis rotundato-quadratis, ad limbum rugoso-radiatis. Glabella subconica, tuberculo centrali antico, sulcis duobus transversis, lobis basalibus magnis instructa; sulcoque verticali ad marginem ducto. Annuli corporis valde nodosi. Cauda axe magno rotundato, fere per totum caudæ extenso; margine edentulo.

SYNONYMS. *A. pisiformis*, SALTER (1859), in Siluria, pp. 45, 53, foss. 4 and 9; *A. princeps*, id., \* Memoirs Geol. Survey, vol. iii. (ined.), pl. 5.

Certainly the lowest and most rudimentary form of Trilobite, and greatly resembling in some respects the young stages of higher groups. But *Agnostus* shows at once its mature character in the possession of a large caudal shield, well developed, and generally quite as large as the head. The surface is sometimes much ornamented, especially the border, and the lobes are often well marked out both in the cephalic and caudal portions. The leading character of the Trilobite family, the facial suture, is altogether absent, and there are no eyes in any of the species.

When Brongniart described this fossil for the first time, he evidently could not tell what to make of it. To describe the head and tail as distinct animals was natural enough, but when he turned the hinder part of the head forwards, and suggested that the basal lobes of the glabella might be eyes, and the forehead lobe the abdomen, &c., one feels that he was justified in saying, "*On ne sait à quelle classe des règnes organiques le rapporter.*" Beyrich first gave the entire form in his treatise, "Ueber einige Böhmische Trilobiten," 1845.

\* The reader must understand that the numerous references to Memoirs Geol. Survey, vol. iii. (ined.) throughout this Decade apply to the forthcoming Memoir on the "Geology of North Wales," by Professor Ramsay; with an Appendix on the Fossils by Mr. J. W. Salter.

It is instructive to find this, the most rudimentary form, associated with other genera in which all the characters of the group are fully developed, in the same primordial zone. But it is to be noted, that either by excessive reduction, as in *Agnostus*, or excessive multiplication of segments, as in *Paradoxides*, the genera at this early period exhibit a defective organization as compared with those of later formations. There is no sort of equality between an *Agnostus* or *Olenus* and a *Phacops* or *Phillipsia*.

The figures we give of *A. princeps* possess more than an usual interest, for they represent some of the oldest fossils known in N. Wales which occur in the lower part of the "Lingula flags," considerably below the characteristic *Lingulæ* of the formation. They are in countless numbers in the black slates near the waterfall of Felyn Rhyd, near Maentwrog, and are there associated with a new *Olenus*, and with rare specimens of *Lingula*. That they are characteristic of the formation is evident from the fact that with the reappearance of black earthy slate in the upper division of the formation, the *Agnostus* reappears also in abundance, and our figure 3 is from that part of the series. In S. Wales other and new genera accompany the *Agnostus* in the lowest portions of the deposit.

*Description.*—Not half an inch long, though frequently elongated by pressure beyond that length. The general form of the head and tail is about two-thirds of a broad oval, truncated next the thorax, pretty regularly convex, and strongly trilobed; the thorax joints do not together occupy one-third the length of the head, and are narrower than its width.

The head is a little longer than broad, smooth, with a narrow distinct border. The glabella about as wide as the cheeks below, but tapering forwards; and divided, at more than two-thirds its height, by a transverse furrow which separates it into two parts, the lower oblong oval smooth, without lateral indentations, and the upper a spherical-triangular lobe, from the end of which a dividing line runs forward to the margin. A conspicuous pair of triangular lobes lie at the base of the glabella, in part subtending the convex cheeks, which are narrow below, broadest above, but narrower again in front, where they are separated by the dividing line.

Thorax of two nodose joints, the anterior largest. Each is strongly trilobate; the pleuræ convex, and with a strong groove toward the tips, making them appear notched (fig. 1 *a*). The axis too is trilobate, the central lobe very prominent, and strongly dis-

tinguished from the lateral and more forward portions ; these are obliquely ovate,—the centre lobe is pyramidal.

Tail nearly of the same shape as the head ; the margin furnished, toward its hinder edge on each side, with a prominent tooth. The axis is very broad and convex, somewhat clavate, and reaching nearly to the margin, a space the width of the latter being left between ; it is of greater breadth than the sides (even including the narrow margin). The front pair of lobes are distinct, rounded-triangular, and their own diameter apart ; the second pair (fig. 3, 4) occupy a less width, are not very distinctly circumscribed, and are divided from the large terminal lobe by a faint transverse furrow. The tubercle on the intermediate pair is prominent but short ; it scarcely invades the terminal lobe, and is of nearly the same shape in all our specimens, however distorted.

*Variations.*—Our larger specimens fig. 1, 4, (fig. 5 is magnified) from the lowest and upper *Lingula Flags* have the axis of the tail rather longer and somewhat more pointed than in fig. 3, but this may be entirely due to elongation from pressure. The terminal lobe of the glabella too is shorter in proportion in the former, but there seems to be no other real difference. The rugose veins which ornament the limb are always conspicuous in well-preserved specimens, but are much obliterated in less perfect ones, as our figures will show.

*Affinities.*—Compared with Angelin's incorrect figures of *A. pisi-formis* and *A. planicauda* (I have Swedish specimens of those species before me), *A. princeps* has the axis of the tail (though Angelin's figures have it too short) decidedly longer, and reaching so far as to leave a space, between it and the margin, of only the breadth of the latter ; and the tubercle, which Angelin represents as elongated and reaching far down the middle of the axis in his *A. planicauda*, is very short and prominent in our species. In both these respects they agree better with Swedish specimens of *A. pisi-formis* than with Angelin's figure ; and if it were not for the longer glabella and tail axis, the larger size and the decided radiation of the limb in our fossil, we should have united ours with the well-known Scandinavian form. Our second variety  $\beta$  is more like it than the first and more ornamented one,  $\alpha$ .

In size *Agnostus princeps* nearly rivals the largest of the Swedish forms, *A. reticulatus* and *A. aculeatus*, Angelin, pl. 6, fig. 10, 11. These, however, show a strong reticulation of the

surface, instead of the more or less faint radiations of the British fossil. And *A. exsculptus* (fig. 8), which is still more like ours, has no posterior spines, and a very short glabella.

We may notice two distinct varieties, possibly species.

1. *A. princeps*,  $\alpha$ . *ornatus*,—glabella fere trilobá antice obtusá, limbo radiato-sculpto, pl. 1, figs. 4, 5.
2. *A. princeps*,  $\beta$ . *rudis*,—glabella bilobá, anticè acutiori, limbo vix radiato, pl. 1, figs. 1, 2, 3.

*British Localities and Geological Position.*—Var.  $\alpha$ . LOWER AND UPPER LINGULA FLAGS, figs. 4, 5, from Carreg Wen, near Borth, Portmadoc. Var.  $\beta$ . LOWER LINGULA FLAGS, figs. 1, 2, Pen-y-foel, a hill close to the Waterfall, Maentwrog, N. Wales (in great abundance). UPPER LINGULA FLAGS, fig. 3, Penmorfa Church, near Tremadoc. The species is also found in the UPPER LINGULA FLAGS (Black Shales) of Whiteleaved Oak, Malvern, where it was first collected by the late Mr. Hugh Strickland. UPPER TREMADOC SLATE, Portmadoc. LOWER LLANDEILO, St. David's Head, rare.

If I were disposed to divide the genus, as Corda and McCoy have done, the *Agnostus tardus*, Beyr., *A. glabratus*, Ang., and *A. trinodus*, Salter, would form a separate group. I prefer to regard them as forming a sub-genus only, *Trinodus*, while the species with transverse lobes to the glabella and caudal axis may stand as *Agnostus* proper, and *Condylopyge*, Corda. Lastly, the smooth forms with all but undivided caudal and cephalic shields (*A. integer*, Beyrich, *A. glandiformis*, Angelin), &c., would form a fourth division, *Phalacroma*, Corda, as follows :

- Section 1. *Condylopyge*, Corda.—Glabella distinct and lobed, the forehead lobe wider than, or as wide as, the posterior ones. Ex. *A. Rex*, Barrande; *A. McCoyii*, *A. Morea*, Salter, &c.
- Section 2. *Agnostus*, Brongn.—Glabella distinctly lobed, the forehead lobe narrower. Ex. *A. pisiformis*, Brong., *A. princeps*, Salt.
- Section 3. *Trinodus*, McCoy.—Glabella not lobed. Ex. *A. tardus*, Barr., *A. trinodus*, Salter, &c.
- Section 4. *Phalacroma*, Corda?—Glabella or caudal axis scarcely marked out at all. Ex. *A. integer*, Beyr. English examples doubtful.

The foregoing Species belongs to *Section 2.*—AGNOSTUS proper.

[AGNOSTUS PISIFORMIS, *Linn.*

I subjoin a description of the Swedish species, as it is necessary to show in what respects this long-known primordial species differs from the preceding, and also from the *A. McCoyii*, under which name I have designated the species common in the Llandeilo flags of Britain, and which was formerly published in the Silurian System as *A. pisiformis*.

SYNONYMS. *Entomostracites paradoxus* and *E. pisiformis*, *Linn.*, *Iter Scan.* 122 ; *Syst. Naturæ*, ed. 16, vol. iii. 160 ; *E. pisiformis*, *Wahl.* ; *Agnostus pisiformis*, *Brongn.* (1822), *Crust. Foss.* pl. 4, fig. 4 ; *Angelin*, (1852), *Pal. Succ.* t. 6, fig. 7 (*A. planicauda*, *ib.* t. 6, fig. 9, variety).

DIAGNOSIS. *A. elongatus*, 5 lineas longus, valde trilobus, capite et pygidio ovali-truncatis, lævibus. Glabella longiconica, in duas partes, anticam trigonam parvam, posticam oblongam, divisa. Cauda axi magno, longo, lobato, apice obtuso ; marginibus angustis brevidentatis. Locality.—*Lingula flags of Sweden.*

Comparing, then, the Swedish figure with that given of our next species, it will be seen that the general shape of *A. pisiformis* is much longer, and the glabella narrower and more pointed ; its upper lobe, instead of being larger than the lower, is much smaller, and from its apex a longitudinal furrow runs to the front margin. In these respects it agrees with our *A. princeps*, as before said, but differs from the Llandeilo fossil *A. McCoyii*.

There are also considerable differences in the caudal shield, as will be seen by referring to the following figures.]

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*Section 1.*—CONDYLOPYGE.

AGNOSTUS MACCOYII.

PLATE I. FIGS. 6, 7.

DIAGNOSIS. *A. oblongus*, depressus, capite pygidioque rotundatis, et ad thoracem contractis. Glabella oblonga, antice vix incrassata, in duas partes sub-æquales, posticam circularem, anticam lunatam, sulco curvo divisa. Limbus undique æqualis, lineis impressis radiatis sæpe notatus, margine angusto. Cauda capiti simillima, sed axi clavato brevi, lobo terminali majori semielliptico, mediano transverso brevityberculato, lobis anticis prominulis. Margo distinctus, brevidentatus.

SYNONYMS. *A. pisiformis?* *Murch.* (1837), *Sil. Syst.* pl. 25, fig. 6 (fig. 4 in text), not of *Brongniart* ; *Diplorrhina triplicata*, *McCoy*

(1851), Pal. Foss. Woodw. Mus. pl. 1 E., fig. 11 [not of Corda]; *Agn. McCoyii*, Salter (1854), in Morris's Catal. Brit. Foss., 2nd ed.; id., Mem. Geol. Surv., vol. 3 (ined.), pl. 13, fig. 8.

A very frequent fossil in the black Llandeilo flags of Builth, in Radnorshire, but, as far as I know, not found elsewhere. It accompanies the *Ogygia Buchii* and *Ampyx nudus*, figured in a former decade, and seems, like many others of the genus, to have delighted in a habitat of black carbonaceous mud, now converted into shale.

*Description.*—A minute species, never half an inch long, even when head and tail are taken together (the body rings have not yet been found). The head is rounded, not oblong, forming about two-thirds of a circle, the base being contracted where it joins the thorax. The tail is nearly of the same shape, a little more oblong. In both the convex limb is nearly equal all round, and the glabella and caudal axis are short and obtuse. The outer marginal rim is narrow but prominent all round, and the two short marginal teeth are placed far back on the caudal border.

The general shape thus given, we may notice a few details. The glabella in front is remarkably broad and obtuse, always as broad, and sometimes (fig. 7) broader than in the hinder moiety. A curved depressed line separates the front portion from the hinder lobe, and the two portions are about equal in length. The basal lobes are small and inconspicuous.

The limb is gently convex, and slopes equally on all sides away from the central lobe, from which a sharp furrow separates it all round; one or two faint depressed radiating lines occur on the limb. The margin is strong and continuous, but narrowest posteriorly, where it ends on each side with a projecting tubercle or minute spine. The small basal or neck-lobes are transverse.

Body rings unknown. (They might surely be found at Builth by collectors.) Tail of the same shape as the head, broadest posteriorly, margined all round distinctly, and with a pair of spines which occur on the sides, so far back as to be on a level with the hinder margin. The axis is short and obtuse, not reaching much above halfway down the tail, and leaving a broad equal limb. The axis is divided very unequally by a transverse line into an upper and a lower lobe, at the junction of which is the prominent tubercle characteristic of the genus. The lower or terminal lobe of the axis is as broad as long, the upper lobe twice as broad as long; a pair of minute lateral



transverse lobes at the margin of the axis lie above this, one on each side.

*Locality and Geological Position.*—UPPER LLANDEILO FLAGS. Builth, Radnorshire; Llandeilo, Caermarthenshire; Marrington, Wilmington, and Shelve, Shropshire.

---

AGNOSTUS MOREA.

PLATE I. FIG. 13.

DIAGNOSIS. *A. minor, capite radiato, radiis profundis bifidis. Glabella angusta subclavata.*

*Description.*—A small species, and the only one detected by Mr. Lightbody and myself in the black shales west of the Stiper stones.

It is remarkable for the strong radii on the limb, which are bisected halfway out by intermediate furrows. About seven of these principal radii occur on either side. The glabella is narrow and rather short, somewhat clavate, the sides constricted below the upper third, where the transverse furrow occurs. The basal triangular lobes are of rather large size.

Named after the Rev. J. More, of Linley Hall, under whose hospitable guidance it was found in the following—

*Locality and Geological Position.*—LOWER LLANDEILO (Arenig group) of Cefn Gwynlle, W. of the Stiper Stones, Linley, Shropshire.

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Section 3.—TRINODUS, McCoy.

A. LIMBATUS.

SYNONYMS. *A. trinodus*, Mem. Geol. Survey, vol. ii. pt. 1, pl. 8, fig. 11 (not figs. 12, 13, which belong to *A. trinodus* proper), *A. limbatus*, Salter, Mem. Geol. Surv., vol. iii. (ined.) p. 41.

I only introduce the references to this imperfect fossil to complete our account, and induce collectors to pay attention to a rare form.

*Locality and Geological Position.*—Caradoc, Wexford. (Survey Coll.)

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## AGNOSTUS TRINODUS.

## PLATE I. FIGS. 8—10.

DIAGNOSIS. *A. brevis, semiuncialis.* Caput suborbiculare, glabellâ convexâ, nec ultra  $\frac{2}{3}$  capitis extensâ, integrâ; limbo convexo. Cauda transversa, convexa; axi miruto conico, vix dimidium caudæ efficiente; utrinque biloba, tuberculoque magno. Limbus posticus convexus, à margine bispinoso et ab axe profunde sejunctus.

SYNONYMS. *Trinodus agnostiformis*, McCoy, Sil. Foss. Irel., pl. 4, fig. 3; in Pal. Foss. Woodw. Mus., t. 1 E., figs. 12, 13 (not fig. 11); *T. tardus*, ib., fig. 9 [*A. glabratus*, Angelin, Pal. Suec., t. 6, fig. 5].

The original figure in the Memoirs of the Survey was not quite satisfactory, for the tail segment (from decomposing limestone near Haverfordwest) had lost its axis furrows and its marginal spines. It is replaced by better specimens in our Museum from Ayrshire. The head has been found more abundantly than the pygidium, and is at once distinguished from all other British published forms (except the kindred species, *A. limbatus*) by the simplicity of its glabella, in which, and many other points, the species closely resembles *A. tardus*, Barrande.

There was a wrong reference in my first description of this species, for I quoted Professor McCoy's synonym for the *A. limbatus* next described, regarding both as varieties of the *A. trinodus*, and giving the present one the varietal name,  $\beta$ . *convexus*. McCoy corrected this error in the Cambridge work, where he again figured two imperfect heads of the species. I hope now to have remedied all our deficiencies by these excellent specimens, chiefly obtained by Professor Wyville Thomson from Ayrshire.

*Description.*—A small species, not above five lines long and three lines broad, very convex for the genus. The head and tail rounded, with a narrow equal border all round, very distinct and separated by a sharp sulcus. In the head the limb is equal in breadth in front and on the sides, separated by a sharp line from the short parabolic glabella, which has no lobes or furrows of any kind. It is a little constricted about the middle, and is rounded at its base, just above a pair of small transverse basal lobes. The posterior angles are contracted and minutely mucronate (fig. 8 a).

The body rings are not known.

The tail (fig. 10, 10 a) is semioval, the upper angles not contracted like the base of the head, but rectangular. The central lobe is

shorter than the glabella of the head, and hyperbolic rather than parabolic in outline; its breadth at base is greater than the whole length. A sharp sulcus surrounds the central lobe, which has two pairs of furrows faintly marked out; the upper ones transverse and reaching far inwards, the middle pair of furrows rather below the middle. A prominent round tubercle ornaments the centre of the lobe, of larger size than usual in the genus. The limb is very convex, and the marginal rim is broader than that surrounding the head; it has a pair of strong short spines on its outer and lower border, which are placed higher up than in *A. McCoyi* and *A. princeps*, before described.

*Affinities*.—There is no trace in *A. tardus* (Barr. Boh. Trilob., pl. 49) of the slight lateral indentation in the glabella, which indicates the position of a furrow. Nor are there any traces in his specimen of the lateral spines to the tail, any more than in the allied Swedish form, *A. lentiformis*, Angelin. But the *A. glabratus* of Angelin, a Caradoc form from Besstorp, in Vestrogothia, is far more like, and if I might suppose that his artist had made the form too elongate, and drawn the tail axis too large, I should consider it identical. The body rings in his species are very clearly shown (and ours should be sought for). The second ring differs a good deal from the anterior one.

*Localities and Geological Position*.—Haverfordwest, S. Wales; Bala and other localities in N. Wales; Shineton, near Cressage, Shropshire, &c.; Chair of Kildare, Ireland; Penwhapple Burn, &c., Girvan; Ayrshire.

*Foreign*.—Probably Vestrogothia (D.), as *A. glabratus*, Angelin.

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#### Section 4.—PHALACROMA?

AGNOSTUS.—*Sp.*

PLATE I. FIG. 12.

We have only the caudal shield of a species resembling the *A. nudus* of Beyrich (more like that species than any British one). The central portion is but faintly marked out; it is, however, smaller in proportion to the limb than in the Bohemian species.

The length of the pygidium is less than two lines. It is long-semioval, the border concave, and is nearly as broad as the axis,

which is half the length of the tail, not very strongly marked out, and has a small anterior prominence.

The Caradoc or Llandeilo flag species, *A. limbatus*, Salter, is somewhat like it in the broad and somewhat duplicated border, but differs in the much smaller axis, and more backward position of the central tubercle. Our species, imperfect as it is, is distinct from and lies midway between this species and the Bohemian *A. nudus*, a primordial form.

*Locality and Geological Range.*—LOWER LLANDEILO (Arenig group). Tai hirion, west of Bala, collected by J. W. Salter in 1853.

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*Section 1.*—AGNOSTUS?

AGNOSTUS TRISECTUS.

PLATE I. FIG. 11.

DIAGNOSIS. *A. caudâ subrotundâ ineremi, axi longo trilobato, multi-segmentato. Axis fere percurrens, latus, ad medium constrictus et tuberculatus, sulcisque longitudinalibus binis approximatis exaratus.*

Two specimens only have been sent to Mr. Tennant of this rare species. It is very like *A. princeps*, from which it differs, at first glance, by the central narrow ridge on the axis, running down throughout its whole length. It is, besides, apparently a flatter species, and has no trace of the posterior spines, but in their place a simple swelling of the margin on each side. This character is unusual.

It is a small species, the tail not being above a line and a half in diameter. It is about as broad as it is long, much rounded in outline, very slightly convex, but the flatness may perhaps be due to pressure. The axis is very broad, and the basal lobes—those next the thorax—are broader and longer than usual, and nearly equal and similar to the second lobe of the axis. The large terminal ovate lobe is longer than the other two put together. All three are deeply divided along the middle line by a pair of parallel furrows, which divides the axis into three strong lobes; hence the trivial name.

*Locality and Geological Position.*—UPPER LINGULA FLAGS. Black Shales of Whiteleaved Oak, Malvern. Probably not uncommon; it is a conspicuous species.

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## EXPLANATION OF PLATE I.

- Figs. 1-5. *Agnostus princeps*, Salter, specimens from various localities and in different states.
- Figs. 1, 2, are from the Lower Lingula flags of Felyn Rhyd Waterfall near Maentwrog, and only show the radiations faintly. [Fig. 1. is the most perfect known, and fig. 1 *a* is the same magnified. Mus. Pract. Geology]. Fig. 2 is a piece of the compressed slate, showing the ordinary condition of the fossils.
- Fig. 3. Variety from the Upper Lingula flag of Penmorfa, under the church. A small specimen, magnified. The natural size is indicated by its side.
- Figs. 4, 5. Large specimens of the typical form with the radiations. Upper Lingula flag, Carreg Wen farm, near Borth, Portmadoc.
- Figs. 6, 7. *Agnostus (Condylopyge) McCoyii*, Salter, from the Upper Llandeilo flag, Builth. Fig. 6 shows head and tail of a small specimen; 6 *a* the same magnified. Fig. 7 a large head, natural size and magnified. (Mus. Pract. Geology.)
- Figs. 8, 9, 10. *Agnostus (Trinodus) trinodus*, Salter. Fine specimens from the Caradoc rocks of Ayrshire, presented by Prof. Wyville Thomson to Mus. Pract. Geology. Figs 8, 9. Heads, natural size; 8 *a*, magnified. Fig. 10. Tail natural size and magnified.
- Fig. 11. *Agnostus trisectus*, Salter. Upper Lingula Flags, Black Shales, Malvern. Mr. Tennant's cabinet.
- Fig. 12. *Agnostus (Phalacroma?) sp.* Specimen from the Lower Llandeilo (Arenig group) of Tai hirion, W. of Bala. (Mus. Pract. Geology.)

J. W. SALTER.

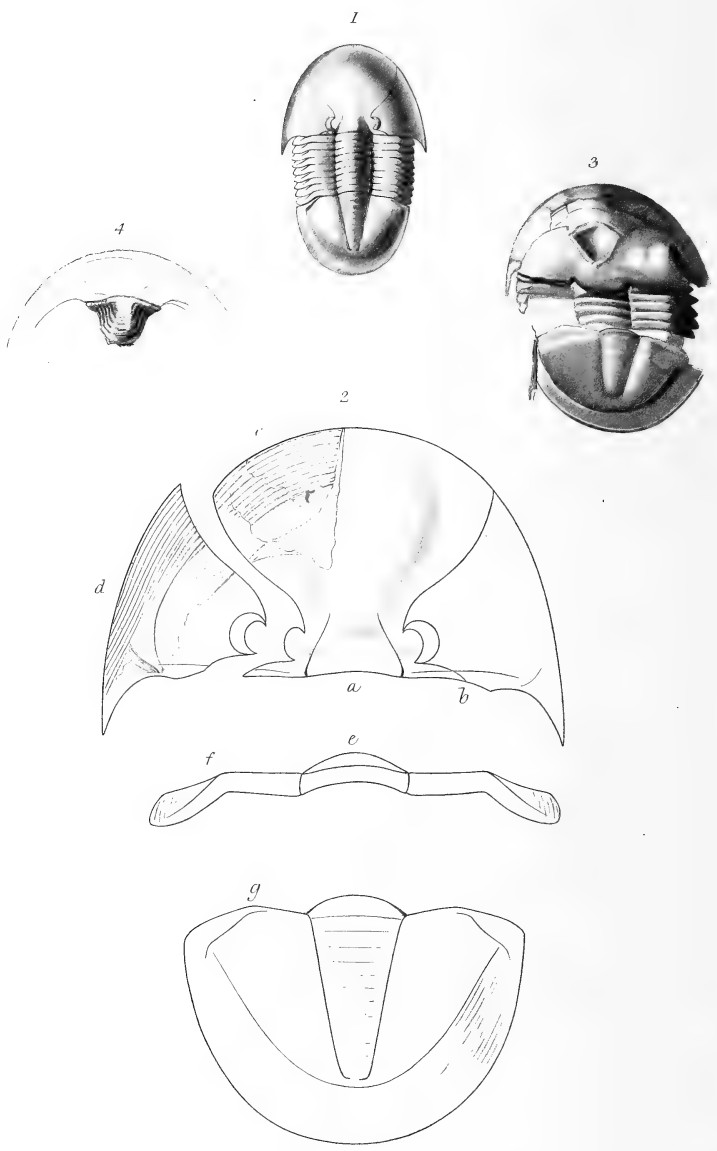
November 1864.





Geological Survey of the United Kingdom.

STYGINA  
(Lower Silurian)



STYGINA LATIFRONS — *Salter.*



# BRITISH FOSSILS.

## DECADE XI. PLATE II.

### STYGINA LATIFRONS.

[Genus STYGINA. SALTER, 1852. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Asaphidæ.) Body ovate, flattened; head and caudal shield nearly equal; body of nine rings; eyes small, placed far backward and inward, near the base of the glabella, which is quite distinct above, and much contracted below. Facial suture marginal along a wide space in front, and below the eyes curved outward and ending on the posterior margin. No rostral shield. Labrum convex, entire. Axis of body narrow. Pleuræ without furrows. Caudal shield with a long axis.]

DIAGNOSIS. *S. sesquiuncialis*, ovalis, axi angusto; spinis capitis brevissimis. Caput semiovale, obtusum, glabellâ ad basin angustissimâ, oculis retrorsis, fere ad basin capitis retractis. Cauda semiovalis, obtusa, axi subannulato.

SYNONYMS. *Asaphus latifrons*, PORTLOCK, Geol. Rept. Londonderry and Tyrone, pl. 7, figs. 5, 6. *A. marginatus*, ib., fig. 7. *Stygina latifrons*, SALTER (1852) in Rep. Brit. Assoc. Trans. Sect. p. 59. Id. "Siluria," 1st ed. 18, and 2nd ed. 1859, p. 184, Foss. 26, fig. 2.

Among the many new and interesting forms of Trilobites described by Colonel Portlock in his work on Londonderry and Tyrone, a small species of *Asaphus* is recorded from the Lower Silurian of Tyrone, which he named *A. latifrons*, distinguishing it from some other species by the breadth of front included within the curve of the facial suture. The species is remarkable for the position of the eyes, which are placed far backward and inward, so as to be close to the base of the small and narrow glabella. This peculiarity of habit is associated with some other characters which will remove the species from *Asaphus*. The flattened oval form, long axis to the tail, and the head spines, much resemble those of *Asaphus*, from which the nine ungrooved pleuræ effectually distinguish it. In the partial obliteration of the glabella, number of body rings, and course of the facial suture, it is closely allied to *Illænus*, from which its habit differs so much; and there is enough of the under side preserved to show there was no rostral shield, which last is an essential character of *Illænus*.

*Description.*—The general form is depressed and elliptical, the length about  $1\frac{1}{2}$  inch, the breadth 1 inch. The contour of the head, which is exactly as long as the caudal shield, and more than one-third the whole length, is nearly a true semi-oval, evenly convex except on the median line behind (which is abruptly raised), and slopes on all sides to a concave border. The glabella, scarcely defined at all in front, though faintly indicated (more strongly so in young specimens), is of a pyriform shape. Posteriorly it is much contracted, and again suddenly expanded upon the neck border. Its greatest width behind is not above one-fifth that of the head. The eyes are small, convex, much curved, placed at less than their own length from the hinder margin, opposite the contracted part of the glabella, and rather further apart than the width of the thoracic axis. The facial suture runs out nearly at right angles beneath the eye, and in front of it describes a large arc, diverging from the eyes at an angle of  $70^\circ$ , and cutting the anterior border far outwards, in a line overhanging the fulcral points. The facial suture is strictly marginal in front, and the hypostome, fig. 4, appears to be quite continuous, without a rostral shield as in *Illænus*, or a vertical suture, as in some *Asaphi*.

Two good specimens in Dr. Wyville Thomson's cabinet show the labrum, but its margin is broken off. It is wide at its attachment, considerably convex in the middle, more so than in *Asaphus*, and is marked with concentric lines on the sides. There is not enough to show that there was no marginal groove, or whether the tip was rounded and entire, as in *Illænus*, which is most probable.

Thorax of nine rings, not so long as the head, and with its axis only two-thirds as wide as the pleuræ, convex. Pleuræ flat as far as the fulcrum, which is about the width of the axis remote from it. Thence the pleuræ are bent down and a little back, and faceted for rolling up. There is no groove whatever to the pleuræ, which thus resemble those of *Illænus*.

Tail semi-oval, blunt, not convex, the conical axis about half the width of the sides, and reaching fully two-thirds the length of the tail. Our figure 2*g*. has it too long. The axis has about eight faint furrows. The sides are gently convex at first, and then broadly concave, with a somewhat sharply defined margin; it is without any furrows,—even the usual upper one is obsolete, or nearly so. The apex is very blunt, more so than the front of the head. The incurved striated portion is broad, and not indented by the point of the axis.

By some accident my name is attached to this species on the plate. Our specimens are those figured and described by Portlock.

*Locality and Geological Position.*—CARADOC of Desertcreat, Tyrone.

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#### OTHER SPECIES OF THE GENUS.

I only know one other British species, and no foreign ones.

**S. MURCHISONIÆ**, Murch.—*S. convexus, trilobus, capite longo semi-ovato, spinis productis. Cauda longa, axe prominulo levi.*

**SYNONYMS.** *Ogygia Murchisoniæ*, MURCH., Silurian System, 1837, pl. 25, fig. 3. *Stygina Murchisoniæ*, SALTER in Siluria, 2nd ed. 1859, pl. 4, fig. 1. MORRIS, Catal. 2nd ed. p. 115, 1854.

Although only a single specimen of this has been found, there can be little doubt of the genus to which it should be referred. The contracted axis of the head and body, and the smooth tail with its strong axial lobe, are at all events extremely like those of *Stygina*.

*Locality.*—In LLANDEILO FLAGS? Mount Pleasant, Carmarthen. It is, however, probable these are Caradoc strata.

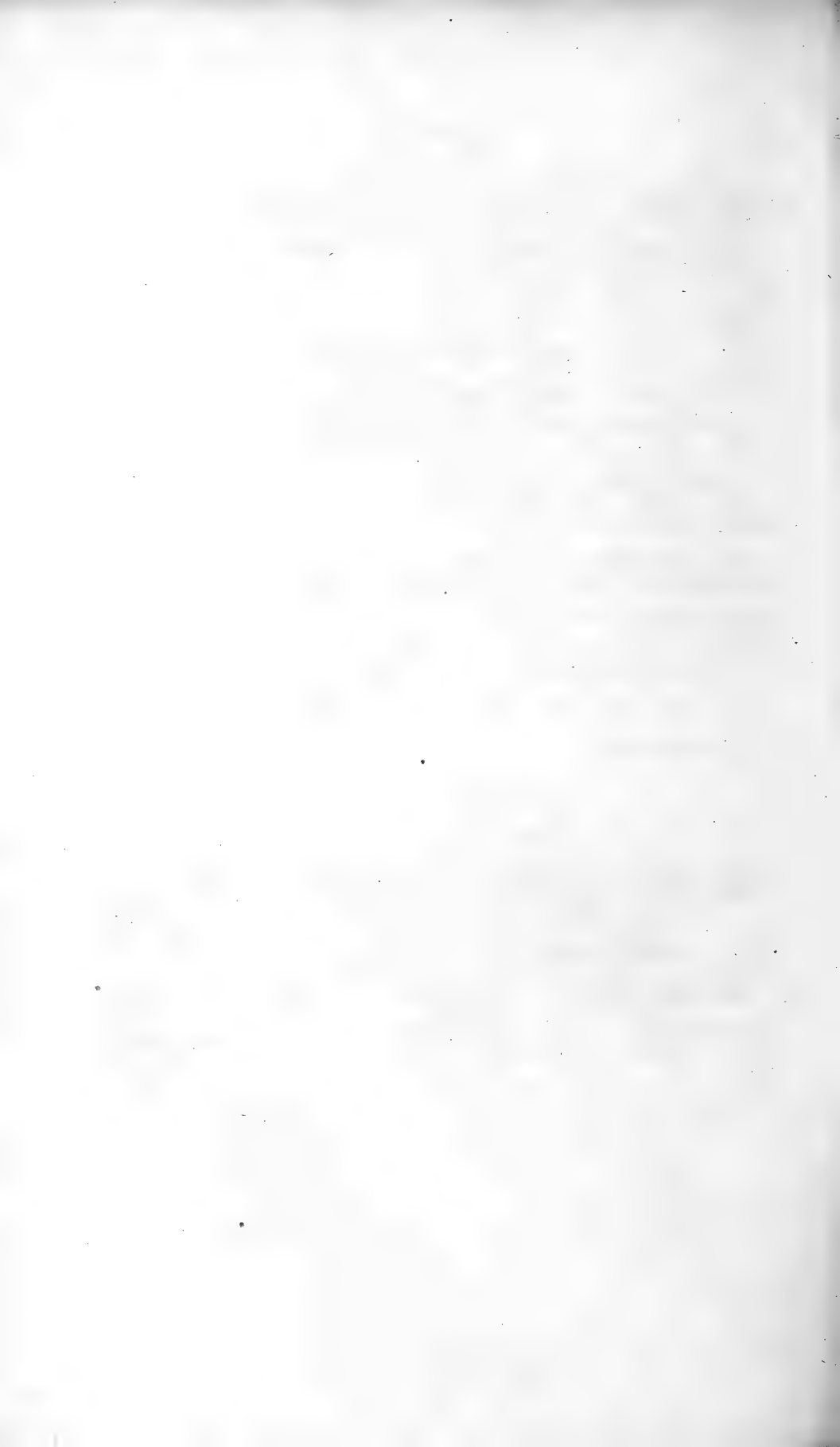
J. W. SALTER.

November 1864.

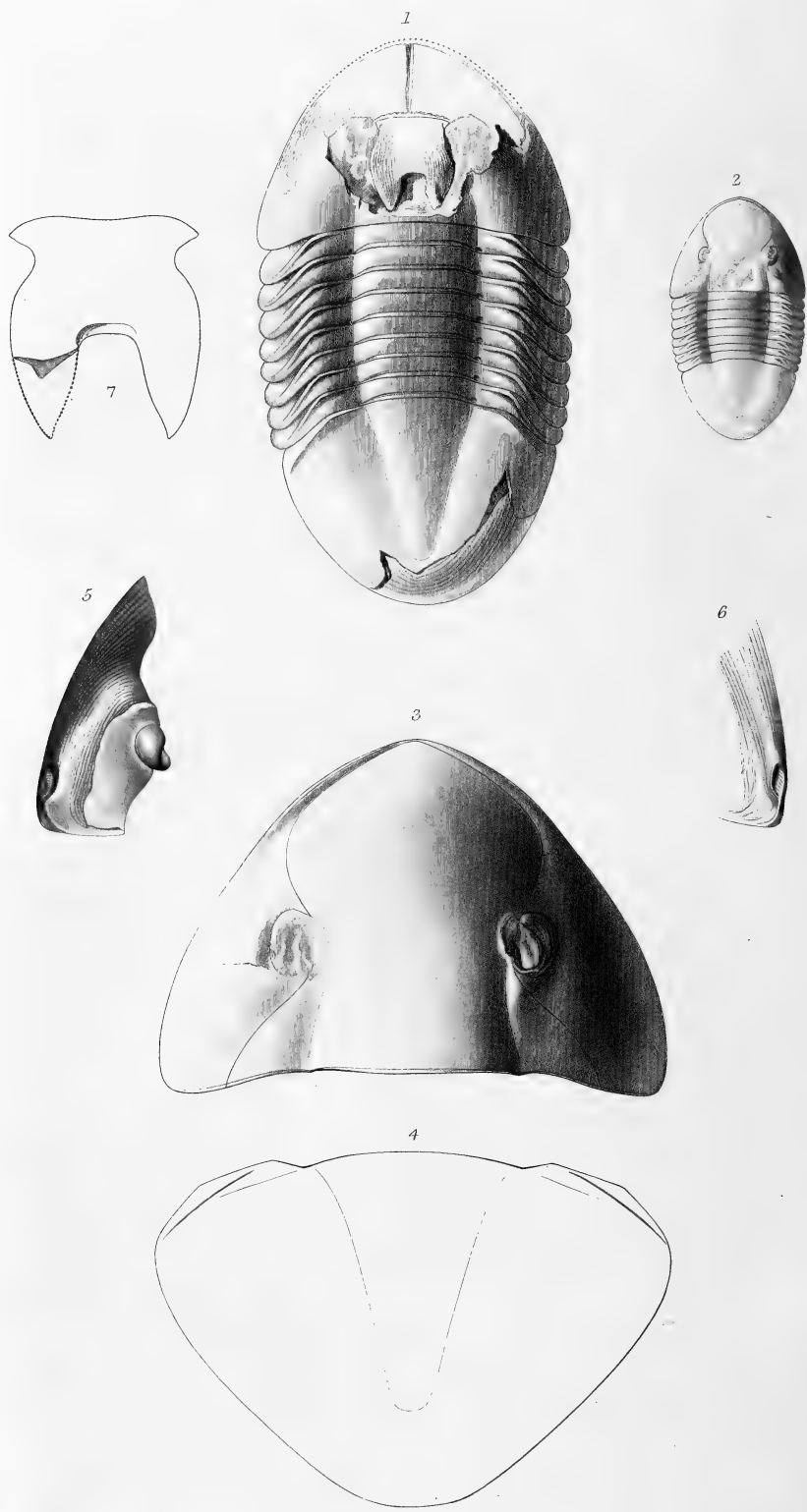
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#### EXPLANATION OF PLATE II.

- Fig. 1. Portlock's original specimen figured in the Geological Report on Tyrone.  
 Fig. 2. Dissected head of the same, showing obscure pyriform glabella, its base (*a*) only convex, and part of the striated incurved portion *c, d*, continuous with the hypostome to the short posterior angle, where it is obliquely folded. At *b*, the termination of the facial suture beneath the eye.  
 Fig. 2. *e, f*, thoracic rings of the same; *g*, tail showing the fulcrum.  
 Fig. 3. Larger specimen (the figured specimen of *A. marginatus*, Portl.), showing impression of the labrum *in situ*.  
 Fig. 4. Under surface of one of Prof. Thomson's specimens, with broken labrum showing concentric lines.







ASAPHUS (ISOTELUS) GIGAS... *De Kay.*

# BRITISH FOSSILS.

## DECADE XI. PLATE III.

### ASAPHUS GIGAS.

[Genus ASAPHUS. BRONGNIART. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Asaphidæ.) Eyes large, smooth. Facial suture marginal or supramarginal in front, and ending on the posterior margin. No rostral shield. Labrum strongly bifurcate. Body rings eight.]

[Sub-genus *Isotelus*. DE KAY. Facial suture intramarginal in front, and with a vertical suture beneath; head scarcely at all lobed; pleuræ much bent down; tail large, with faint axial furrows and no lateral ribs.]

DIAGNOSIS. *I. ovali-oblongus lævis, lateribus rectis; capite pygidioque æqualibus subtrigonis hyperbolicis. Caput sulcis axialibus minime profundis. Oculi modici pone medium capitis positi. Sutura facialis intra marginem frontalem parallela; labro\* ad basin angusto, furcis longis parallelis. Thoracis axi pleuris æquali, fulcro ad tertium posito. Cauda axi indistincto angusto conico longo, limbo sulco unico superiore, reliquis nullis.*

SYNONYMS. *Asaphus platyceph.*, STOKES (1822), Trans. Geol. Soc., London, i. 8, p. 208, pl. 27. *Isotelus gigas* and *I. planus*, DE KAY (1824), Annals of the Lyc. of Nat. Hist. of New York, vol. i. p. 176, pl. 12, 13, fig. 1. *Asaphus gigas*, DALM. (1826), Palæad. 71. *Isot. gigas*, GREEN (1832), Mon. of Tril., p. 67; also *I. planus*, p. 68, *I. stegops*, p. 71, *I. cyclops*, p. 69, and *I. megalops*, p. 70. *Brongniartia isotela*, EATON (1832), Geol. Text Book, pl. 2, fig. 19. *Asaph. platyceph.* BRONN. (1835), Leth., vol. i. p. 115, pl. 9, fig. 8. *Asaph. gigas*, EMMR. (1839), Dissert. 32, 12. *Isotelus gigas*, MILNE-EDW. (1840), Crust., vol. iii. p. 298. *Asaph. platyceph.*, BUCKLAND (1840), Bridg. Treat., vol. ii. p. 76. *Asaph. platyceph.*, BURM. (1843), Org. Tril., pl. 2, fig. 12, Ray, ed. (1846), p. 110. PORTL. (1843), Geol. Rep. *Isot. gigas*, pl. 7, figs. 1-4, pl. 8, fig. 7; *I. planus*, pl. 7, figs. 2, 3 (except pl. 8, figs. 2, 3); *I. ovatus*, pl. 8, fig. 5; *I. sclerops*, pl. 10, fig. 2; *I. Powisii*, pl. 6, fig. 1. *I. megistos*, LOCKE (1842), Amer. Journ. Science, vol. xlii. p. 366; Trans. Assoc. American Nat. and Geologists (1843), vol. i. pl. 6. *I. gigas*, HALL (1847), Pal. New York, pl. 60, fig. 7; pl. 61, figs. 3, 4; pl. 62, figs. 1, 2; pl. 63. *I. gigas*, BILLINGS (1863), Geol. of Canada, p. 184, fig. 182 (and *I. platycephalus*, ib. fig. 183?)

\* I prefer this term to hypostome, used in the former Decades. The hypostome of Dalman is the incurved front margin.

I have figured this fine species from General Portlock's original specimens, and I follow most writers in adopting De Kay's name, because it must have been contemporary with the publication of Stokes' paper (though the latter was read early in 1823). Even were *A. platycephalus* a little the earlier name, it was published without any description. And it is just possible that the fossil described by Stokes may belong to a different species.

*Description.*—General shape oval-oblong, with the sides rather straight, the head and tail nearly equal, and both subtriangular, the head pointed, the tail more obtuse at the tip. The surface is convex when the fossil has not undergone compression, a line taken from the snout to the apex of the tail being a regularly convex one, uninterrupted by any neck furrow, depression, or convexity of the smooth and even body rings, or furrows on the axis of the tail. The axial furrows are very obscure in the head; they are neatly marked but shallow along the body, and only very faint along the tail. All the surface is smooth. The sides are strongly deflected, but not steep.

The head has the shape of a broad and pointed Gothic arch, the breadth at base being to the length as three to two. The margin is very narrow and flat, rather than recurved. The facial suture forms a broad ogive arch in front, running for some distance close within and parallel to the front margin; and, beneath the eyes, which are large, placed near the glabella, and rather behind the middle of the head, the suture curves gently out and cuts the posterior margin midway from the axial furrow. The hinder angles are blunt pointed, not rounded. On the under side of the cheek near the point is a convex space, containing an oval depression, which receives the apices of the front pleuræ in rolling up (fig. 6, and see also fig. 5 for the cast of this depression on the matrix). The labrum (fig. 7) has a narrow base, then a strong constriction, and thence the sides are parallel. The apex is deeply furcate, the parallel forks occupying nearly half the entire length of the organ. Body rings smooth, rounded at the apices, deflexed at the fulcrum, which is placed rather beyond one-third, and with a broad strong groove. Tail sub-triangular, with straight sides, and rounded blunt tip. The faint axis rapidly tapering, broad conical, and reaching three-quarters the length. Sides quite smooth.

In young specimens, says Hall, the caudal extremity is more pointed, and exhibits marks of eight articulations; in older specimens these increase in number. But the crust presents many



traces of them when viewed from within ; they are often distinct (Hall, l. c. 231). Burmeister also calls attention to this character. It appears to be frequent in the genus and its allies, for I have seen Swedish specimens, both of *Asaphus* and *Illænus*, which exhibited it strongly, chiefly on the axis. In like manner the lobes of the glabella often show internally, though quite obliterated on the external crust. I have not seen them in this species, but Burmeister gives them in his figure, of which he boasts the absolute accuracy. We can at least say as much for ours, so far as the specimens exhibit character ; and our plate of this species is alike creditable to the artist, Mr. Bone, and the engraver, Mr. Lowry.

*Variations.*—There seems to be some reason to think there may be two species in the American limestones ; one rarer, of broad form and with small eyes—the true *A. platycephalus* of Stokes ; the other very common, of elongate form, and with variably large eyes, to which nearly all the above synonyms belong. See figures of both forms in the “Geology of Canada,” 1863, by Sir W. Logan and E. Billings, p. 184. I have quoted these above. On the other hand, I should have no difficulty in referring these differences to sex, the broad *A. platycephalus* being the ♀ form.

*History.*—It is not necessary to refer to the American authors, who have profusely illustrated this common species. But I feel persuaded that Prof. Hall is right in uniting all Green’s casts under one name ; the more so as Hall had several hundred specimens at command in every degree of perfection. Prof. Green’s species are chiefly due to differences of position, and in attempting too closely to identify each of these, Gen. Portlock separated the Irish specimens he described into more forms than can be now admitted. *I. gigas* and *I. planus* of Portlock he himself considers identical. *I. ovatus*, id., differs in nothing but its size ; the head is really not more elongate than in his specimens of *I. planus* ; and with regard to his *I. Powisii*, the more depressed form is entirely due to pressure ; and the fulcrum is at the same proportional distance,—about one-third from the axis (not more distant, as stated) ; the appearance is due only to the before-mentioned cause. The true *A. Powisii*, Murch., has distinct ribs to the tail, square ends to the pleuræ, and a swelled glabella, but the Irish specimens all resemble *I. gigas* in these respects. I do not know that the true *A. Powisii* occurs in Ireland, while *I. gigas* is not known in England.

The large *Isotelus megistos*, which is certainly the same species with *I. gigas*, has been reconstructed in the form of a cast by

American authors, as of enormous size. The cast which is commonly sold for lecture purposes indicates a form 21 inches long; but there is no pretence for making it more than two-thirds this length. *Asaphus gigas* is not one of the largest of Trilobites.

*Locality and Geological Position.*—CARADOC of Tyrone (Portlock). The species ranges from Canada to Tennessee, and it is rather remarkable that it should abound in N. Ireland without reaching further to the eastward. Some other American species appear to range to Ireland, but are not otherwise members of the British Silurian fauna.

#### OTHER BRITISH SPECIES OF THE SECTION ISOTELUS.

2. *I. rectifrons*, Portlock, Geol. Report, 1843, pl. 9, fig. 1 *a, b*; also pl. 8, figs. 2, 3, 7, only referred to under *I. planus*. These belong to the head. *I. arcuatus*, ib., pl. 9, figs. 2, 3 (tail of same species). *I. intermedius*, ib., pl. 9, fig. 5.

Head semicircular convex; the angles rounded, and showing the characteristic pit for the pleuræ some distance above the angle. Glabella between the eyes about equal in width to the cheeks. Eyes large, placed much behind the middle of the head, and very much curved. Eye-line straight and directed outwards above the eye to the front margin, along which it runs. Beneath the eye it runs outwards, nearly parallel to the posterior margin. In the front of the head there is no vertical suture, the front being striate and showing rather a narrow base for the attachment of the labrum.

The tail and body Portlock called *I. arcuatus*. The body segments have the axis broader than the pleuræ, which have the fulcrum close in, and are bent back from it and rounded at the ends. The tail is wider than a semicircle; the upper angles are much bent down for the facet. The axis is marked out at its origin by two rather deep impressions, and is here rather wider than the side lobes. Thence it is not indicated, except by a slight prominence at its apex, which reaches to three-fourths the length of the tail. A broad shallow furrow beneath the fulcrum is all the marking that shows on the smooth convex sides.

Incurved portion narrow, concave; its edge not indented by the point of the axis; strongly lineate, the lines abutting sharply against the margin.

*I. intermedius* is too like the species just mentioned to be catalogued as distinct. It is much pressed out of shape and

obscured. But the *I. læviceps* of this author, though not the same as the *As. læviceps* of Dalman, is probably a member of the section *Cryptonymus*, a group which has the axis and glabella lobes well marked out, and often has very prominent eyes. It is very rare in England and absent in America, but is the common form of the genus in the Swedish area.

*Asaphus lævigatus*, Angelin., Pal. Succ., pl. 29, fig. 1, in many respects resembles *A. rectifrons*.

*Locality*.—Caradoc of Desertcreat, Tyrone.

3. *I. sp.* Salter, in Quart. Geol. Journ., vol. vii. pl. 8, fig. 2. A caudal portion of an undetermined species has been figured by Sir R. I. Murchison in his paper on the Silurian Rocks of the S. of Scotland. It is probably distinct from *I. gigas*.

4. ? Another is quoted in Prof. Nicol's paper on the Peeblesshire Silurians, Quart. Journ., vol. iv. p. 205, which is lost now, but was stated by myself to be allied to *Asaphus (Isot. megistos) gigas*. Both these species require further illustration; but they seem to show the gradual dying out of the American type *Isotelus* in its range eastward, as above noticed. Possibly both are referable to *Megalaspis*.

The distribution of subgenera over the northern zone is as follows:—

| <i>N. American Types.</i> | <i>British Types.</i>                          | <i>Scandinavian Types.</i>                               |
|---------------------------|------------------------------------------------|----------------------------------------------------------|
| <i>Isotelus</i> , common. | <i>Isotelus</i> , rare, N. and N. West only.   | [ <i>Isotelus</i> , absent.]<br><i>Basilicus</i> , rare. |
| <i>Ptychopyge</i> , rare. | <i>Basilicus</i> , common, also in Mid-Europe. | <i>Cryptonymus</i> , common.<br><i>Nileus</i> , common.  |
|                           | <i>Cryptonymus</i> , very rare, in N.W. area.  | <i>Megalaspis</i> , do.<br><i>Ptychopyge</i> , do.       |

#### EXPLANATION OF PLATE III.

Fig. 1. *Asaphus gigas*, De Kay, the original specimen figured by Portlock as *Isotelus planus*, De Kay. It shows the vertical suture to the hypostome and the labrum in place.

Fig. 2. Do. (Portlock's original of *I. ovatus*.)

Fig. 3. Do. (Portlock's figured specimen of *I. sclerops*.)

Fig. 4. Tail of do.

Fig. 5. Cast of under surface of side of head, showing the eye, and the pit for the reception of the ends of the pleuræ.

Fig. 6. Gutta percha cast of the same specimen, showing the real under surface.

All the above are from the Caradoc of Desertcreat, Tyrone, and are in the Mus. Pract. Geology.

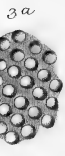
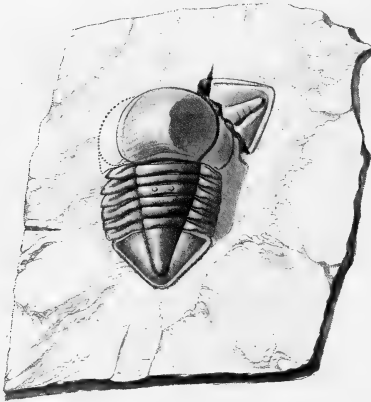
J. W. SALTER.

November 1864.

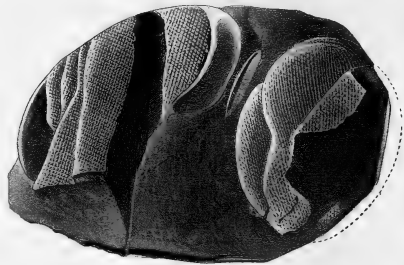




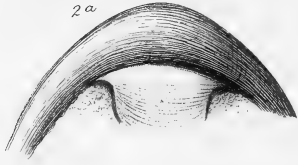
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9a



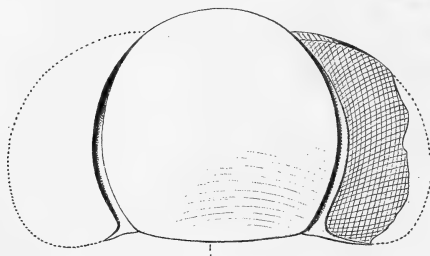
2a



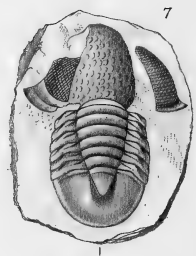
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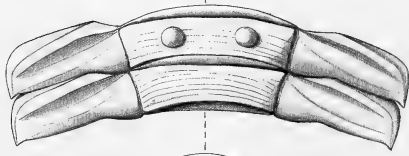
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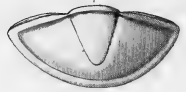
7



4



8



5



Figs 1-6. ÆGLINA BINODOSA - Salter  
7-8 ——— GRANDIS ? id  
9 ——— SP.

# BRITISH FOSSILS.

DECADE XI. PLATE IV. FIGS. 1-6.

## ÆGLINA BINODOSA.

[Genus ÆGLINA. BARRANDE, 1847. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Asaphidæ.\* Body oblong, the extremities equal, rounded. Head convex, glabella large, rounded or parabolic, not distinctly lobed; eyes very large, occupying the whole, or nearly the whole cheek, coarsely granulated (externally?); facial suture ending on the posterior margin close to the axis. No rostral shield. Thorax with five or six rings, the axis broad, the pleuræ faceted and grooved. Tail large, the axis of two or three rings, abbreviated; the sides few-ribbed, or nearly smooth. *Cyclopyge*, Corda.]

DIAGNOSIS. *Æ. lata, biuncialis et ultra, convexa, capite grandi inflato, lævi; segmento thoracis tertio binodoso; caudâ triangulatâ profundè marginatâ.*

SYNONYMS. *Æglina binodosa*, SALTER, Siluria, 2nd ed., p. 50, Foss. 8, fig. 6. Id. Mem. Geol. Surv., vol. iii. ined., pl. 11 B. fig. 3.

The genus has been previously illustrated in Decade VII., but from less perfect materials.

*Description.*—About an inch long, and three-quarters broad in the widest part; the head very blunt in front, and the tail tapering acutely. The glabella is round and inflated; the axis of the body tapers quickly backwards, and the tail is truly triangular. These characters and the tubercles on the third body segment will easily enable the collector to identify it.

The head is seldom perfect, but, from many specimens, must have been transverse-oblong, while the glabella is perfectly round, inflated, and showing no trace of lobes or furrows. It has a narrow border down the sides, marking the course of the facial suture, and separating the glabella from the broad lunate eyes, which are coarsely granular (fig. 3) and occupy the whole cheek. As usual in the genus, the inflated glabella shows no trace of a neck segment.

\* For the present I do not wish to cut up this large natural group. But a better knowledge of the primordial forms of it will doubtless render it necessary to do so by and by. *Æglina* has some relation to *Remopleurides* (*Olenidæ*).

Beneath the head the hypostome is continuous (fig. 2 a) and tumid, without rostral shield or any suture, and the convex labrum has rather a broad base, as in *Illænus*.

The thorax is convex, and has a wide and much tapering axis, broader than the sides. It is greatly wider in front than its pleuræ, and behind is not quite so wide as these. Its rings are gently arched, and the third one bears a pair of those enigmatical tubercles which are of so common occurrence along the central lobe of Trilobites.\* The front pleuræ are very short, and the hinder elongated. They are more curved forward than our figure indicates, at least in the central and hinder rings. The fulcrum is near the axis, the groove broad, not deep; the apices truncate, and a little pointed behind. The facet is long and narrow.

The tail is truly triangular, and except that the apex is rounded off, would be an equilateral triangle, deeply and strongly margined all round, and with a narrow conical axis which reaches two-thirds and rather more of the length. Its tip is rounded, and it is marked by a single broad ring at the base, and very faint traces of two or three others.

*Variations.*—Young specimens, which I have seen since the plate was engraved, in the choice cabinet of Mr. H. W. Edgell, show the metamorphosis. In a specimen which is barely two lines in length, the number of rings to the body is only four, and the fourth ring is scarcely separable from the caudal shield. The axis of the latter is narrower than in full-grown specimens; but I do not see much other difference.

This is one of the most conspicuous species of the genus, and in great plenty in the black slate of one locality. It differs so markedly from all the other species, in the triangular tail with a prolonged axis, that it is unnecessary to compare it with any. It appears to have grown to a less size than *Æ. grandis* next described.

*Locality and Geological Position.*—LOWER LLANDEILO FLAGS (Arenig group), Cefn Gwynlle, in the district west of the Stiper Stones, Shropshire; in black slate, abundant. My friend, Dr. A. Fritsch, of Prague, tells me he has found the same species in the Lowest Llandeilo beds (d. 1) of Prague. I suppose it a closely allied, not identical, form.

\* They have been specially noticed in my memoir on the *Phacopida*, Palæont. Transact., vol. for 1862, p. 52. And they are conspicuous under various forms in *Enerinurus*, *Cheirurus*, *Sao*, and a host of other genera. Probably they indicate the places of cutaneous glands, but their purpose is not yet evident.



## ÆGLINA GRANDIS.

## PLATE IV. FIGS. 7, 8.

DIAGNOSIS. *Æ. ovalis*, 2-3-uncialis, depressa, tuberculatâ, axe corporis angusto; caudâ rotundatâ lævi, lateribus unisulcatis.

SYNONYMS. *Æglina grandis*, SALTER, Siluria, 2nd ed., p. 53. Foss. 9, fig. 6. Id. Mem. Geol. Surv., vol. iii. (ined.) pl. 12, fig. 11.

*Description*.—Oval (rather depressed?)  $1\frac{3}{4}$  inch long; head more than two-fifths the whole length, with a large glabella without lobes, covered with rather prominent tubercles. This character is so remarkable in the genus that no long description is necessary to enable us to recognize the species. The eyes are very large, as long as the head, and there appears to be a larger border beyond them than usual in the genus.

Body of six rings, the axis narrower than in most of the species, broadest in front, contracted behind, where it scarcely equals the pleuræ in width. These are bent at the fulcrum, which is placed rather more than one-third out from the axis in the front rings, and nearly at half in the hinder ones.

The tail is semicircular, and has rather a conical axis of two joints, rather long in our figure 8, which I believe is the same species. One obscure lateral furrow (the uppermost) is all that is visible on the smooth sides. A distinct margin runs all round the tail, neatly defined, but not by a broad or deep furrow. The shape of the tail in fig. 7 is much rounded, and more than a semicircle. In fig. 8 it has been compressed longitudinally, and has a shorter aspect; but I believe this is only due to compression in the slaty rock.

The largest specimen I have seen appears to have the fulcrum of the pleuræ further inwards, but agrees in other respects with the remaining specimens; at least it has the tubercular glabella, a character in which our species differs from all others.

Of the two British species previously described; *Æ. mirabilis*, Forbes, has a parabolic and lobed smooth glabella. *Æ. major*, Salter, has a wide body axis, and two lateral furrows in the tail.

All Barrandé's species have a smooth glabella, and are very much smaller than ours, except his *Æ. speciosa*, which has a very broad axis and short marginal eyes.

*Locality*.—LOWER LLANDEILO FLAGS (Arenig group?), South side of St. David's Head, Pembrokeshire.

## ÆGLINA, sp. (EYES OF).

## PLATE IV. FIG. 9.

This large species is perhaps not the largest *Æglina* known; M. Barrande has an enormous one from the Llandeilo rocks of Bohemia, with a projecting front to the head. Ours probably was six inches long, and the great eyes an inch and a quarter long (no other part occurs with them). The eye of this species lay for a long while in the Museum as an undescribed *Bryozoon* from the Llandeilo flag. Contrary to the usual arrangement in the eyes, the lenses are in quincunx, instead of hexagons (see fig. 9 *b*), and very closely set; but in some parts the normal hexagonal arrangement is seen (fig. 9 *c*).

*Locality*.—UPPER LLANDEILO FLAGS of Aberiddy Bay, Cardigan-shire. The rest of the body should be sought for there.

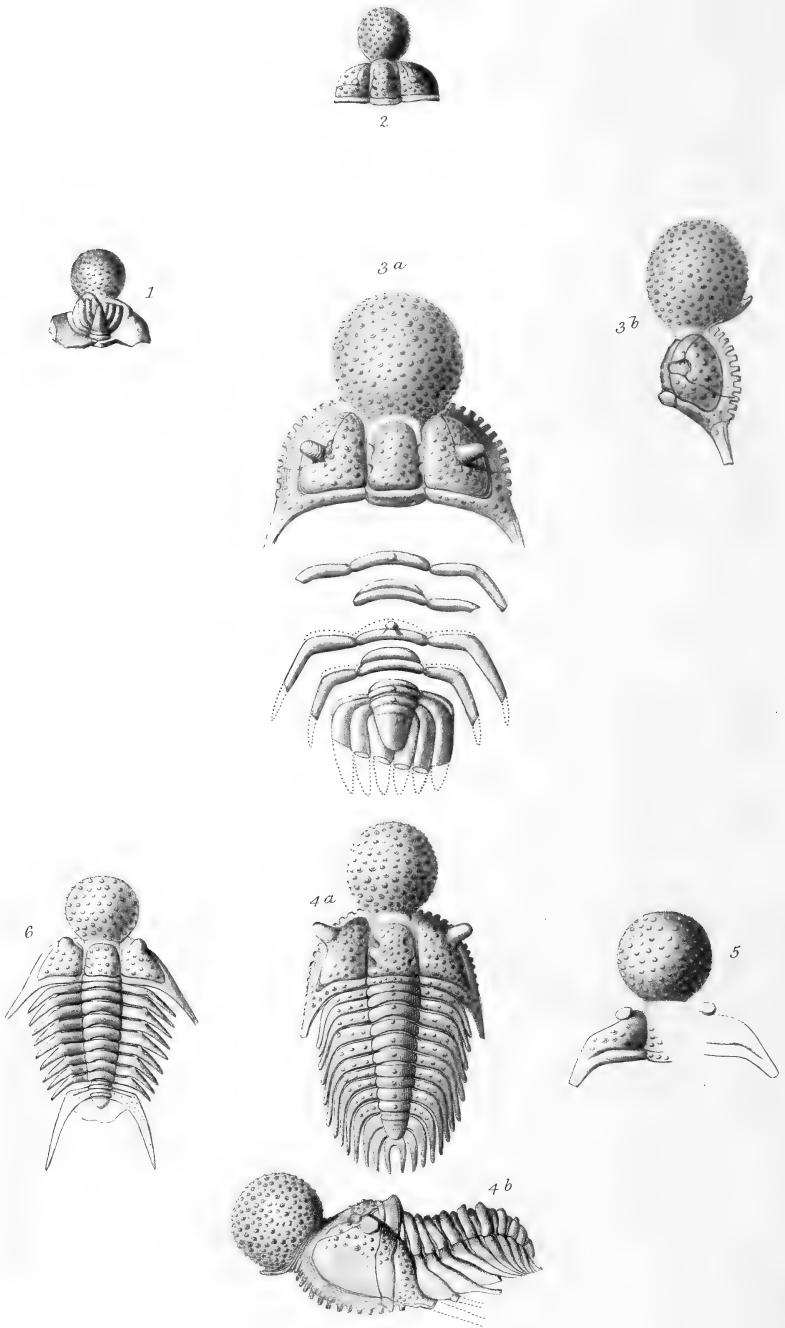
## EXPLANATION OF PLATE IV.

- Fig. 1. *Æglina binodosa*, Salter, nat. size, Lower Llandeilo (Arenig) group of Cefn Gwynlle, Stiper Stones, Shropshire.  
 Fig. 2, 2 *a*, magnified. Labrum and hypostome of do. Same locality.  
 Fig. 3, 3 *a*, magnified. Eye of do.  
 Fig. 4. Body rings, showing the tubercles on the third segment.  
 Fig. 5. Tail, nat. size.  
 Fig. 6. All the above portions are enlarged in this figure.  
 Fig. 7. *Æglina grandis*, Salter. A small specimen from the Lower (?) Llandeilo rocks of Whitesand Bay, St. David's, Pembrokeshire.  
 Fig. 8. A compressed tail. Same locality.  
 Fig. 9 *a*. *Æglina*,—*sp.* An enormous species, of which we have only the great eyes in their natural position. The slate is much compressed and folded. 9 *b*, *c*, magnified parts of the eye. Upper Llandeilo, Aberiddy Bay, Pembrokesh.  
 All the above are in the Mus. Pract. Geology.

J. W. SALTER.

November 1864.





*Figs. 1, 4 (5?) STAUROCEPHALUS MURCHISONI — Barr*

6

— — — — — *GLOBICEPS — Portlock*

# BRITISH FOSSILS.

## DECADE XI. PLATE V.

### STAUROCEPHALUS MURCHISONI.

[Genus STAUROCEPHALUS. BARRANDE, 1847. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Cheiruridæ.) Head cruciform, with long clavate glabella, greatly swelled in front into a hemispheric lobe, the base narrow cylindric, with three pairs of furrows. Cheeks convex, with pedunculate eyes and serrate margin. Facial suture ending on the external margin. Body rings 10, without pleural grooves, pointed. Tail of few segments, the apices of the pleuræ free. *Barrande.*]

DIAGNOSIS.—*S. ovatus, tuberculosus, oculis remotiusculis, margini genarum spinoso. Cauda quadrata, pleuris omnibus æqualibus retrorsis parallelis, haud divaricatis.*

SYNONYMS. *Staurocephalus Murchisoni*, BARRANDE (1852), Syst. Sil. Bohême, pl. 43, fig. 28-32. *S. Murchisoni*, SALTER, in Siluria, 2nd ed. 1859, p. 540; Id., Morris's Catal., 1854, p. 115.

One of the most curious, though not most conspicuous, of our British species. The globular head, or rather glabella, set on its narrow stalk-like base, the gibbous cheeks, projecting eyes, serrate border, and spiny comb-like pleuræ and tail, combine to give an extravagant and unusual appearance to the fossil. It is seldom found perfect. But the skill of the Dudley naturalists has long been exercised on it, and specimens are now to be found in many cabinets. Mr. Hollier's specimens are the principal ones figured. Mr. Ketley has some fine ones, and our figs. 1, 2, are from the Museum of Practical Geology. They were formerly part of Mr. E. Davis's collection at Presteign.

*Description.*—About an inch long, of which the gibbous head occupies more than two-fifths. This is longer than broad, roughly triangular in general outline, but not truly so. It appears rather four-lobed, or like the heraldic "*fleur de lis*," the truly globular front occupying more than half the length of the glabella, and being at least three times as wide as its semi-cylindrical base, from which it is abruptly cut off by a transverse furrow; the base is marked by two distinct lateral lobes besides the neck furrow. The cheeks reach forward about half way up this globular portion, and the

central part is necessarily raised, so as to be nearly on a level with the glabella.

The cylindrical eyes are on the most convex part of the cheeks, and are directed outwards, scarcely forwards. The margin is distinct in front of the head as a very narrow prominent ridge, and furnished on each side with about 14 truncate spines; the cheek spine is directed backwards, and but slightly outwards, abrupt at its origin, and not reaching beyond the two or three first body rings. The facial suture cuts the outer border in a direct line from the base of the eye.

All the prominent parts of the head are covered with larger and smaller tubercles; they only fail on the deeper furrows, and the truly vertical outer half of the cheeks. They are conspicuous on the border, and even on the cheek spines.

The body and tail united are slightly longer than the head, the thorax of 10 rings many times longer than the short square tail, and the axis about one-fourth the whole width, and highly convex, especially in front. There are no axial furrows to separate the gibbous axis from the horizontal portion of the pleuræ, and these soon curve downward, and are abrupt and steep on the sides.

The pleuræ are semi-cylindrical, the front portion, separated by the pleural groove being very narrow in this and allied genera, placed on the forward margin, and scarcely visible.\* The apices curve much backward, and in the hinder pleuræ a little outward again, and are produced into strong spines beyond the ovate faceted portion. And all along these pleuræ and over the axis tubercles are placed at equal distances, except that the central prominent tubercle fails on alternate rings of the axis, and the intervening ones, especially the ninth, are stronger than any other tubercles, and remind us of the spines on *Encrinurus*.

The tail is nearly square, concave rather than flat, the short conical axis, of four rings, not easily distinguishable from the sides, which are composed of three flat broad spinous pleuræ directed backwards, and quite parallel, so as to give a comb-like appearance. A few tubercles are scattered on the surface.

*Locality and Geological Position.*—CARADOC ROCKS, near Bala, N. Wales (fig. 5); WOOLHOPE LIMESTONE AND SHALE, Corton, Presteign (figs. 1, 2); WENLOCK LIMESTONE, Dudley and Malvern.

\* Yet I doubt the propriety of making this character so important in classification as Barrande has done. The pleural groove is always present in one form or another. In this case it is anterior, in *Cheirurus* it is very short and oblique.

## STAUROCEPHALUS GLOBICEPS.

Pl. V. Fig. 6.

SYNONYMS. *Ceraurus globiceps*, PORTLOCK (1843), Geol. Rep., Tyrone, 257, t. i. f. 7. *Staurocephalus globiceps*, SALTER, in MORRIS'S Catal., 2nd ed. (1857), p. 115.

DIAGNOSIS. *S. ovatus granosus, caudâ elongatâ, spinâ utrinque unicâ divergenti. Glabella stipite brevi vix lobato. Oculi approximati. Spine genales et pleurales diffusæ. Cauda brevis, pleuris primariis longè extensis, latis; reliquis—?*

A much smaller species than the preceding, and distinct from it by abundant characters of shape and habit. The divergent spines of head, thorax, and tail enable us at once to recognize it; and of the latter, the remarkable extended first pair of pleuræ (the rest of the tail is lost) show a near connexion with the *S. ? Maclareni*, afterwards described.

Only one good specimen, 10 lines long, is known. The head is equal to the thorax in length, and longer than the caudal portion. It has a very large globular front, longer than the square stipes, and granular all over. This stalk or base seems to be without furrows. The cheeks granular, gibbous, with a prominent eye on the front edge, near the glabella, and directed forward, not outward; a broad plain margin, and widely divergent spines.

The axis of the thorax is cylindrical, and as wide as the stalk of the glabella. The pleuræ flat as far as the fulcrum, which is less remote than the width of the axis, with patent not recurved spines as long as the portion within the fulera. The thorax tapers backward rather rapidly to the tail, which has a short three-ribbed axis, and the upper pair of its pleuræ are very much expanded, widely divergent, and more arched than in our figure, which also represents the thoracic pleuræ as less curved than they really are. The hinder portion of the tail is absent on our specimen; and I know of no other.

*Locality and Geological Position.*—CARADOC ROCKS of Desertcreat, Tyrone (Mus. Pract. Geology).

A third form, very abnormal in its characters, and of large size, has been named *S. Maclareni* by Prof. Wyville Thomson, after the veteran Scotch geologist, in whose company he found it. It is, however, Prof. Thomson's previously described *Acidaspis unica*. As he has mislaid his own full description, I may supply the following notes, from his specimens and others presented to the Museum of Practical Geology by himself.

## STAUROCEPHALUS? UNICUS.

DIAGNOSIS. *S.*  $1\frac{1}{4}$  *uncialis, oblongus, sparsè granulosus, glabellâ gibbâ eminentissimâ, corpore plano, caudâ expansâ transversâ. Caput latum, glabellâ clavatâ elevatâ frontem longè impendente, a genis punctatis distinctissimâ; margine crasso utrinque bispinoso. Pleuræ subplanæ, sulcatæ, rectæ, apicibus abruptè recurvis. Cauda lata brevis, axi appendiculato, pleuris primariis latissimis spatulatis, margine postico truncato.*

[SYNONYM. *Acidaspis unica*, WYV. THOMSON, Quart. Geol. Journ., vol. xiii. pl. 6, fig. 13.]

In the absence of a figure sufficiently complete (for the one quoted above is very defective), it is necessary to give a rather full diagnosis of this remarkable form, which tends to show the passage of the *Cheirurid* into the *Acidaspid* family. Indeed, if Prof. Thomson be correct in figuring 12 segments to the body, the species is abnormal for either *Acidaspis* or *Staurocephalus*. The shape of the head clearly enough shows that it is to *Staurocephalus*, or else to one of the sections of *Cheirurus*, that this strange fossil must be referred. *Cheirurus* often has 12 segments, *Acidaspis* 9 or 10, *Staurocephalus* only 10. The grooved pleuræ are unlike *Staurocephalus*, but like the section *Eccoptochile* among the genus *Cheirurus*. But no *Cheirurus* has so clavate a glabella, though a tendency towards it is exhibited in some species, and *Sphærocoryphe* of Angelin is very near to ours.

There is an evident analogy too in this form with *Lichas*, both in the shape of the tail and the character of the pleuræ. But the external position of the facial suture far up the cheek easily distinguishes it from that genus. I do not further describe it, as it will appear in a very early plate in the volumes of the Palæontographical Society.

*Localities.*—CARADOC SCHISTS, at the base of the "Orthoceratite and Graptolite flags," Penwhapple Glen, Ayrshire (W. Thomson).

## EXPLANATION OF PLATE V.

- Fig. 1. *Staurocephalus Murchisoni*, Barrande, coiled specimen, natural size. Woolhope Shale, Presteign. (Mus. Pract. Geology.)  
 Fig. 2. Head of ditto, same locality and cabinet.  
 Fig. 3. Magnified figures from the above specimens, completed from Dudley specimens.  
 Fig. 4 *a, b*. Magnified specimen from Dudley. Mr. E. Hollier's cabinet.  
 Fig. 5. Lower Silurian specimen. Rhiwlas, Bala (Mus. Pract. Geol.), nat. size and magnified.  
 Fig. 6. *Staurocephalus globiceps*, Portlock (his original specimen, magnified three diameters).

November 1864.

J. W. SALTER.





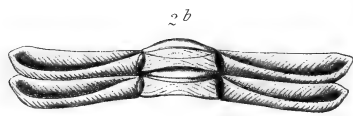
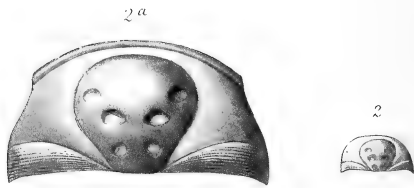
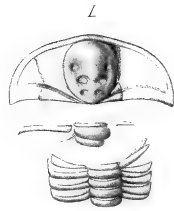


Fig. 1. 2. — SALTERIA PRIMEVA — *Wyn Thomson*

# BRITISH FOSSILS.

## DECADE XI. PLATE VI.

### SALTERIA PRIMÆVA.

[Genus *SALTERIA*. WYV. THOMSON. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Trinucleidæ.) Body oval, tapering backwards. Head large, semi-lunar, margin very narrow, simple, surrounding a broad limb. Glabella inflated, furrowed. Facial suture following the edge, except through a small portion on either side, where it becomes nearly vertical and slightly emarginates the upper surface, cutting off a narrow free cheek. [Eyes minute, linear.] Thorax of few segments. Tail of many segments.]

DIAGNOSIS. *S. fere uncialis, lata, ovata. Caput semilunare limbo angusto brevi convexo marginato; glabellâ ovatâ pyriformi depressâ, genis multo majori, utrinque puteis tribus brevibus notatâ; sutura facialis sub fronte ambitui parallela, dein per quartam partem externam limbi conspicua subverticalis. Thorax articulis truncatis. Cauda triangularis multisegmentata.*

We have no hesitation in placing *Salteria* among the *Trinucleidæ*. It is evidently closely allied to *Dionide*, especially to Angelin's species *D. euglypta*. They have nearly the same form of glabella with longitudinal grooves; the same narrow, smooth, concave limb; the same structure of body rings and tail. The great difference between them consists in the presence in *Salteria* of a distinct though linear free cheek, and apparently of a true eye in its normal position. In these characters our fossil at once recalls *Cyphoniscus*, placed by Mr. Salter, apparently with much reason, among the *Olenidæ*. It also resembles this genus in the peculiar character of a delicate striation on the cast of one portion of the head, while the remainder is smooth. We have a specimen of *Cyphoniscus* from the same beds in Ayrshire retaining the free cheek, and showing a well marked narrow rim, ending in a long, straight, genal spine. The specimen is unfortunately too imperfect to show the eye. In *Cyphoniscus* the structure of the body rings is quite characteristic, and the small Olenoid tail is very different from the compound tail of *Salteria*.

*Description.*—Length of adult about three-quarters of an inch. Form broadly oval, tapering backwards. Head large, semi-lunar, slightly but regularly convex. The central shield, composed of glabella and fixed cheeks, is widely semicircular, emarginate externally, with a contour nearly corresponding with that of the head. The head is bordered by a distinct but not very broad, smooth, slightly concave margin, which is continuous with the central shield through the anterior half of the margin, but is cut away at the exterior fourth on each side by the curving inwards of the facial suture. The glabella is rounded-trigonal, in front transversely oval and very convex, and slightly prolonged and contracted behind, where it is much flattened; the crust is perfectly smooth. The two posterior glabella furrows on either side are represented by shallow pits, arranged nearly in a square, and occupying the posterior third of the glabella; the anterior pair of furrows by similar depressions more remote, placed near the anterior and outer angles of the middle third. Two longitudinal grooves connect the posterior glabellar depressions with the neck furrow, only shown in our upper figure. The tergal portion of the neck segment is small and convex. The fixed cheeks are large, slightly arched, coalescing before the glabella in a narrow ridge, bordered by a still narrower margin. The lateral portion of the occipital groove passes forwards and outwards two-thirds across the fixed cheek, then slightly backwards to the lateral margin, cutting off nearly one-third of the cheek. The portion of the cheek before the groove is smooth like the glabella, the portion behind it (the neck segment) is marked with delicate striæ parallel to the furrow and to the posterior margin.

In all our examples the free cheeks and the eyes are absent, but from the portions which we possess, and from the analogy of closely allied forms, we may safely supply a facial suture coinciding with the outer edge of the anterior margin, appearing upon the upper surface nearly midway between the centre of the frontal edge and the genal angle, passing gently inwards, and then outwards and backwards through the limb, slightly emarginating the semicircular contour of the head, and so curving downwards and outwards towards the genal angle.

The linear free cheek, bearing probably a linear eye, is absent. In our specimens the posterior angles have an imperfect truncated look, and we should be inclined to believe that, following the analogy of *Trinuclæus*, *Dionide*, *Cyphoniscus*, &c., the lower edge

of the free cheek was prolonged into a genal spine. The labrum is unknown.

The body rings are few? in number. The axis is rather wide and more convex than the pleuræ (epimerals). A deep groove passes diagonally across them, curving slightly backwards from behind the anterior and inner angle of each epimeral portion to the outer and forwards to the outer angle.\* The distal ends of the pleuræ are truncated obliquely forwards.

Of the tail we have only a fragment, but enough to show that it was somewhat triangular, marked with many segments, but fewer than in the tail of *Dionide* (*Polytomurus* of Corda).

We regard the structure of the head in *Salteria* as intermediate between that of *Trinucleus* and some of the *Olenida*. We may expect to find a series, beginning with the distinct facial suture and crescentic eye of *Remopleurides*, then the suture gradually approaching the edge of the head, passing through its position in *Salteria*, *Ampyx*, and *Cyphoniscus*, till it reaches the edge in *Dionide* and *Trinucleus*, the eye becoming more and more linear as it approaches the margin, till when it reaches it, the suture being constantly immersed in mud, and its function in abeyance, it becomes altogether obsolete, and is sometimes replaced by stemmata? jutting out on the epimerals of some of the other head segments.

We have much pleasure in dedicating this remarkable genus to our friend, lately the Palæontologist to the Survey.

*Varieties.*—The only variations which we possess of this species depend on age and size. Our largest specimen (fig. 1) may have been about an inch in length. The glabella is slightly carinated on the posterior third, and the longitudinal grooves are well marked. In smaller examples the glabella ridge is absent, and the longitudinal furrows scarcely perceptible.

*Locality and Geological Position.*—We procured about half a dozen specimens of the head from Schists forming the base of the "Graptolite and Orthoceratite flags," Penwhapple Glen, in the Girvan district;—the equivalents of the "Upper Bala or CARADOC ROCKS."

P. WYVILLE THOMSON.

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\* The groove is more forward than in our figure, so as to leave a larger posterior half to the pleuræ, but the direction of the groove is correctly given.

## OTHER SPECIES OF THE GENUS.

2. In the Museum of Practical Geology there is a head of a small species with a smaller and more pyriform glabella, a wider and more deflected limb (almost involute) in front of it, and a narrow neck segment. It was not found till after the plate was engraved, or should have been added to it. It may be called

## S. INVOLUTA.

DIAGNOSIS. *S. minutus*, capite vix  $3\frac{1}{2}$  lineas lato, convexissimo, ad frontem decurvo gibbo. Glabella pyriformis, dimidium capitis efficiens, sulcis transversis. Sulci cervicales vix arcuati. Oculi haud remoti.

The involute limb in front is really about as broad as the width of the glabella, but is so much curved down that only a part of its breadth is seen on an upper view. The glabella, not equal to the width of the free cheeks at their base, is pyriform in outline, and marked by two pairs of transverse furrows, which indent it far inward, and one pair, the upper one, which is minute and very far outward. The furrow surrounding the glabella is very sharp and deep, but not broad. It separates an extremely tumid limb, which comprises the broad front margin and the convex cheeks. The facial suture cuts the front margin far outward, as in *S. primæva*, but, unlike that species, it then turns sharply inwards very near to the glabella, and then again abruptly outwards, in a wide curve to what must be the extreme end of the cheek.

The neck furrow is sharp and deep, and reaches nearly to the end of the facial suture. It is nearly parallel to the posterior margin, instead of curving forwards as in that species.

The species looks like a dwarfed variety of *S. primæva*, but is really a very distinct one.

*Locality*.—LLANDEILO FLAGS, Newtown Head, Waterford, in the cabinet of Major Austin.

## EXPLANATION OF PLATE VI.

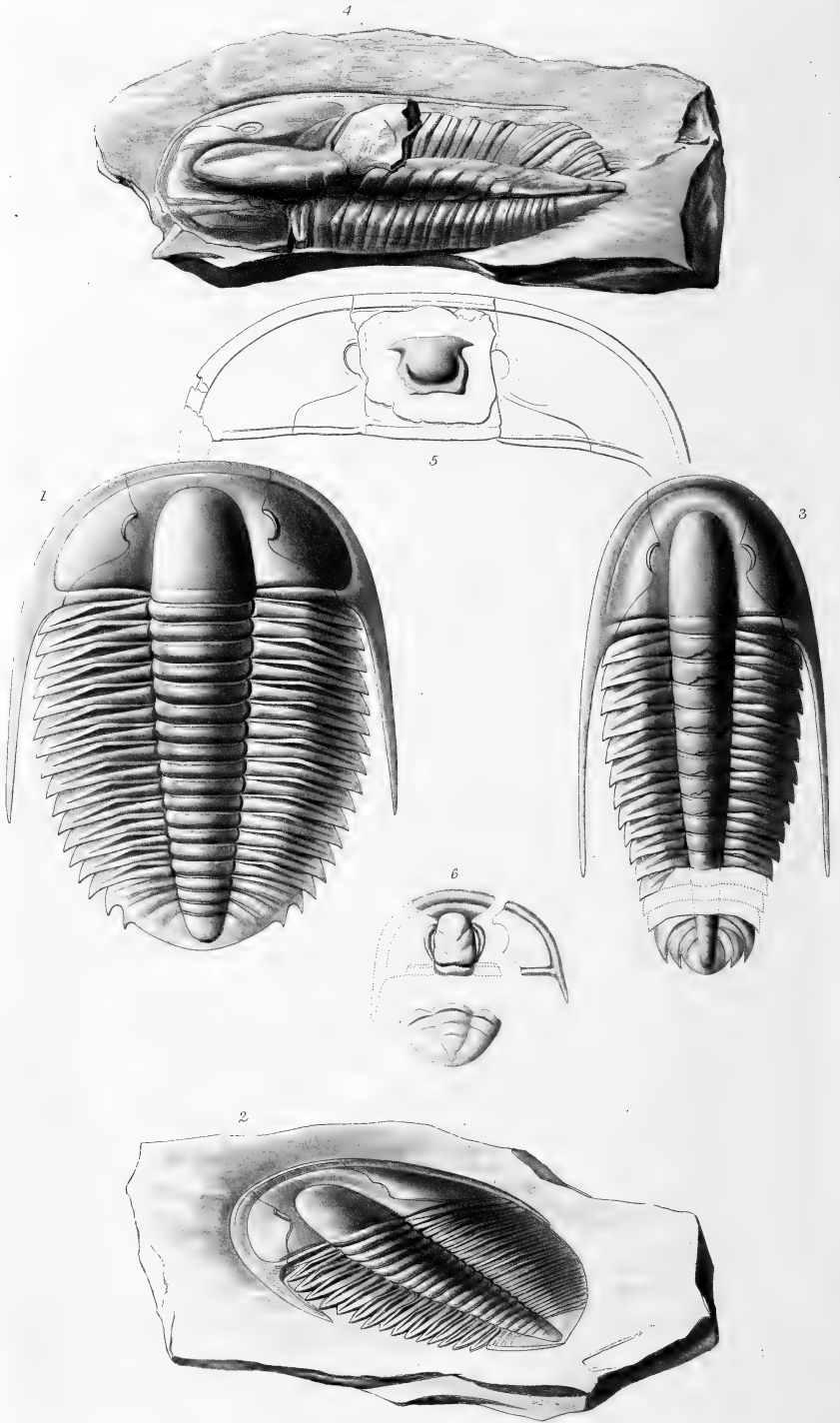
Fig. 1, 2. *Salteria primæva*, Wyv. Thomson; specimens, natural size, from the Caradoc schists of Penwhapple Glen, Ayrshire. (Mus. Wyv. Thomson.)

Fig. 2 a, 2 b, 2 c. The same magnified.

J. W. SALTER.

November 1864.





1-5 ANGELINA SEDGWICKI, *Salter* (Tremadoc Slate)

6 CONOCORYPHE INVITA, *id.* (Up. Lingula Flags)



# BRITISH FOSSILS.

DECADE XI. PLATE VII. FIGS. 1-5.

## ANGELINA SEDGWICKI.

[Genus ANGELINA. SALTER. (Sub-kingdom Articulata, - Class Crustacea. Order Trilobita. Family Conocephalidæ.\*) Depressed, head smooth, and with long posterior spines; eyes small, sub-median, without ocular ridge; glabella lobeless. Body segments 14-15, with an angular fulcrum, faceted for rolling up. Tail of few (four or five) segments. Labrum emarginate.]

DIAGNOSIS. *A. ovata*, segmentis trunci 15, axi quam pleuris paullo angustiori. Caudà utrinque bispinosa.

SYNONYMS. *A. Sedgwicki*, SALTER, Siluria, 2nd ed., 1859, p. 53, foss. 9, fig. 2. *A. subarmata*, ib., fig. 3 (specimens pressed laterally and lengthened). *A. Sedgwicki*, Memoirs Geol. Surv., vol. iii. (ined.) pl. 7.

The new forms illustrated on our plate were part of the results of a survey by myself in 1853 of the "Lingula Flags" and overlying beds in the mountain region extending from Tremadoc to Ffestiniog, and thence to Arenig-fawr, west of Bala. They have since been collected by the hundred, and are really common fossils.

The affinities of the genus are equally balanced between *Olenus* and *Conocoryphe*. *Angelina* differs from *Olenus* by having the pleuræ grooved and faceted for rolling up, instead of flat and produced into points; nor do we know of any *Olenus* that is totally without glabella furrows. It is this latter character, with the occasionally spinose tail, which distinguishes it from *Conocoryphe*; but this is combined with some characters of habit, such as the long head spines, less marked cephalic furrows, both axial and marginal (indicating probably a thinner crust), and much less deflexed pleuræ, with the fulcrum nearer the axis. *Angelina*, too, wants the ocular ridges of *Conocoryphe*. From *Arionellus* the less number of body

\* The *Conocephalidæ* (Salter) differ essentially from the *Calymenidæ* by the variable but larger number of body rings, and the course (posteriorly) of the facial suture. They seem to have had a thinner crust, and, as a character of habit, resemble the *Olenidæ* in the long head spines and often sub-spinous tail border.

rings separates it, and that genus has so broad and expanded a margin, which is without a furrow, and the facial suture so far outwards, that there evidently is but little affinity with *Angelina*. The genus is named in honour of the Swedish paleontologist, who is carefully illustrating the old rocks of Christiania. Two fasciculi of his quarto work are already published, and we wait anxiously for the remainder. His *Calymene? leiostraca*, Pal. Suecica, t. xix. fig. 3, may very possibly belong to this genus.

*Description.*—Usually three or four inches long (one specimen fully six inches), of a broad oval contour, the head blunt, and the tail only moderately pointed. The head occupies less than one-third of the length, and is semicircular, but rather truncated forwards; a narrow equal margin, not raised or thicker in front, runs all round, scarcely broader than the occipital border of the cheek, and continuous with it; an equal space separates this margin in front from the glabella, which is parabolic, much longer than broad, and quite destitute of any lobes. It is about equal in width to the cheeks (exclusive of their margin). The cheeks themselves are gently convex, smooth, and bear the small curved eye midway, but nearer the glabella than the marginal furrow. The facial suture is nearly vertical to them above, and then turns sharply outwards to cut the posterior margin at its outer third.

The labrum is seen on one or two specimens. It has a central raised portion, separated by rather a deep groove from a flat margin, which is broadly and abruptly truncate at the apex.\*

Thorax of 15 segments; the axis narrower than the sides, gently convex, and tapering quite regularly backwards. The pleuræ are nearly direct, slightly produced and bent back at their ends, and grooved throughout. They are bent down a little from the angular fulcrum, which is placed at rather more than one-third in front (our figure shows it too far out at this point), and at much less than one half in the middle segments. The hindermost segments are scarcely at all produced or curved backwards; and all the segments are faceted for rolling. The pleural groove is deepest beneath the fulcral point, and as beyond this the facet bounds it in front, and the posterior edge of the segment is convex beyond the fulcrum, the groove becomes an elongated rhomboidal depression: a feature

\* It is a little like that of *Lichas*, but is without the terminal notch and the "auricles" or lateral wings, and differs from that of *Olenus* by its broad margin. *Conocoryphe* has a labrum without so broad a margin, and not nearly so truncate.

not often seen in those genera in which the faculty of rolling up is lost or very limited.

The tail is more pointed than a semicircle, the axis not as broad as the sides, with two distinct rings, and a bluntish terminal portion not reaching the tip. The sides are marked by two lateral furrows which just reach the margin, opposite to the two short lateral spines. The upper furrows are duplicated. The *incurved under margin*\* is very narrow, but convex.

The compressed and elongated specimens (figs. 3, 4) were formerly considered to be of a distinct species, not, however, on account of the form, which I was aware might be due in great part to pressure, but on account of the spinose border to the tail, a character I had not at the time seen in figs. 1 and 2. A noble series of specimens, distorted in every possible way, have been lately transmitted by Mr. D. Homfray, of Portmadoc, who has collected the fossils of that district with much success.

These specimens show 15 segments (our figured specimens only showed 14), and they prove clearly that the spinose border to the tail occurs in all well-preserved specimens, yet in some more distinctly than others. And the great difference in appearance between figs. 2 and 3 is entirely due to the different direction in which the fossils have been pressed in the stone. The pleural grooves in the one case are all but obliterated (fig. 3), in the other they are deepened (fig. 2), and the spinose border to the tail (in fig. 3) appears to be increased in length; in fig. 2 it is reduced. The somewhat greater space in front of the glabella, and the long head spines in fig. 3, are differences which may possibly (if they be found constant) be referable to sex.

*Locality and Geological Position.*—UPPER BEDS OF THE TREMADOC SLATES, Garth Hill, east side of Traeth Bach, Tremadoc, N. Wales; also Portmadoc Quarries, and at the Ynys Tywyn, in similar beds. (Mus. Pract. Geol., and cabinets of Messrs. Homfray, F. Ash, and Mr. E. Roberts, surgeon, and many other collections.)

#### Genus—CONOCORYPHE.

It is not usual to include more than one genus in a plate; but accident having introduced a *Conocoryphe* upon the plate of

\* We want a term for this incurved striated under margin, which is always more distinct in the tail than elsewhere. Being always or most generally parallel-sided in the tail, it might conveniently be termed the "*caudal fascia*;" in the pleuræ, the "*pleural fascia*," but the term is hardly necessary for any portion but the tail, where the relative width of the *fascia* is of specific importance.

*Angelina*, advantage is taken of it to present the English reader with the characters of a genus which is more common, or at least better known, in Sweden and Bohemia, than in England.

*Conocoryphe* belongs to the same primordial family as *Angelina*, and differs from it chiefly in the lobed glabella. M. Barrande gives the following characters.\*

[Genus CONOCORYPHE. CORDA. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Conocephalidæ.) "Glabella shortened, narrowed in front, with three or four pairs of oblique furrows. Axal furrows deep. Eyes (usually present) reticulate. Facial suture ending within the posterior angle. A rostral shield present. Labrum elongate truncate. Thorax segments 10-15, furrowed and faceted for rolling. Tail entire, of two to eight segments." Barr., p. 417.]

[Section *Conocoryphe* proper. Eyes large, approximate. Glabella large, well lobed; 14 body rings; tail small. Lingula flags only.]

The other sub-genera, *Solenopleura*, &c., will be illustrated in future decades.

#### CONOCORYPHE\* INVITA.

#### DECADE XI. PLATE VII. FIG. 6.

DIAGNOSIS. *C. capite* (*adhuc solùm cognoto*) *lati-marginato, angulis brevispinosis; glabellâ urceolatâ, utrinque bisulcatâ; oculis longis, ad glabellam appressis; caudâ angustâ, axi conico 4-annulato.*

SYNONYM. *Conocephalus invitus*, SALTER, in *Siluria*, 2nd ed., 1859, p. 47, foss. 7, fig. 1. Id. *Mem. Geol. Surv.*, ined. pl. 4, figs. 5, 6, 7; pl. 7, fig. 6.

*Description.*—Of the head we have only fragments, but they show that the facial sutures converge greatly from the margin to the eye, which is very long, reaching two-thirds the whole length of the glabella, from the middle of the large basal lobe to above the upper lobe. The glabella furrows nearly unite in the centre and both pairs are very oblique, the basal pair almost meeting the deep arched neck furrow.

This species resembles so nearly *E. Emmrichii*, Barr., that were it not for the glabella having only two pairs of furrows, the frag-

\* I think, much as we wish to preserve to M. Barrande all the honour of his careful nomenclature, that we cannot safely use the term *Conocephalus* or *Conocephalites* of Zenker, as the term has been employed in no less than three different genera of plants and animals. It is better to adopt Corda's term, the more so, as it is really likely that the subdivision of the genus proposed by him will be hereafter sanctioned,

ments might readily be mistaken for that species. The glabella, however, is longer, of an urceolate shape, and with the furrows reaching much further into it. The eyes are not quite so long, as they do not reach to the base of the lower lobes, and they are set quite close to the glabella, which is not the case in *E. Emmrichii*.

The tail is longer and narrower; the axis conical, with the terminal segment developed. Our species is altogether an excellent British representative of a genus common in Bohemia and Sweden.

*Locality and Geological Position.*—UPPER LINGULA FLAGS. Penmorfa Church and Carreg Wen, Tremadoc, N. Wales. Ogof ddu, near Criccieth. (Mus. P. Geol.)

It may be as well to mention here that 10 species of *Conocoryphe* are already known in Britain. Nine are described in the forthcoming Memoir of Professor Ramsay on the Geology of North Wales; and a fine species, with highly developed ornament, is found in the Lower Lingula Flags of St. David's. As the genus must be illustrated hereafter, I only give the names and references.

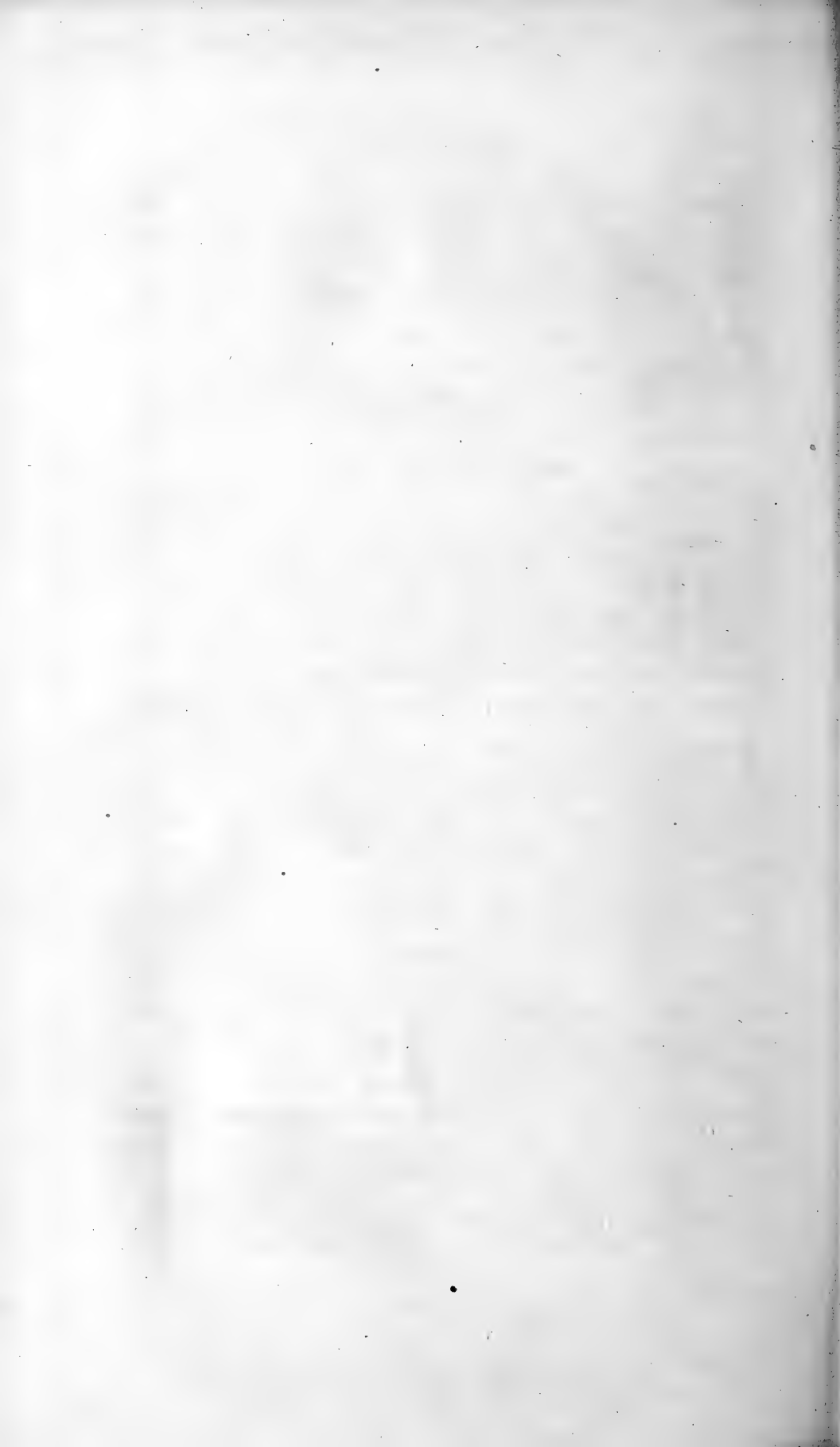
- C. invita*, Salter, Mem. Geol. Surv., vol. iii., ined., pl. 4, figs. 5, 6, 7; pl. 7, fig. 6, above described.
- C. abdita*, id. pl. 5, fig. 13, Upper Lingula Flag, Ogof ddu, near Criccieth.
- C. sp.* id. pl. 5, fig. 14 (fig. 15 tail?), same locality.
- C. sp.* id. pl. 5, fig. 16, same locality.
- C. ? simplex*, id. pl. 5, fig. 17, Upper Lingula Flag, Penmorfa Church.
- C. vexata*, id. pl. 8, fig. 7, Lower ? Tremadoc Slate, Penmorfa village.
- C. depressa*, id. pl. 6, fig. 1, 2, 3, Lower Tremadoc, near Penmorfa Church, and Wern, Portmadoc.
- C. ? verisimilis*, id. pl. 6, fig. 13, Lower ? Tremadoc, above Penmorfa village.
- C. ? olenoides*, id. pl. 8, fig. 6, Upper Tremadoc, Garth, Portmadoc.
- C. variolaris*, id. Quart. Geol. Journ., vol. xx., pl. xiii., figs. 6, 7, Lower Lingula Flags, St. David's, Pembrokeshire.

#### EXPLANATION OF PLATE VII.

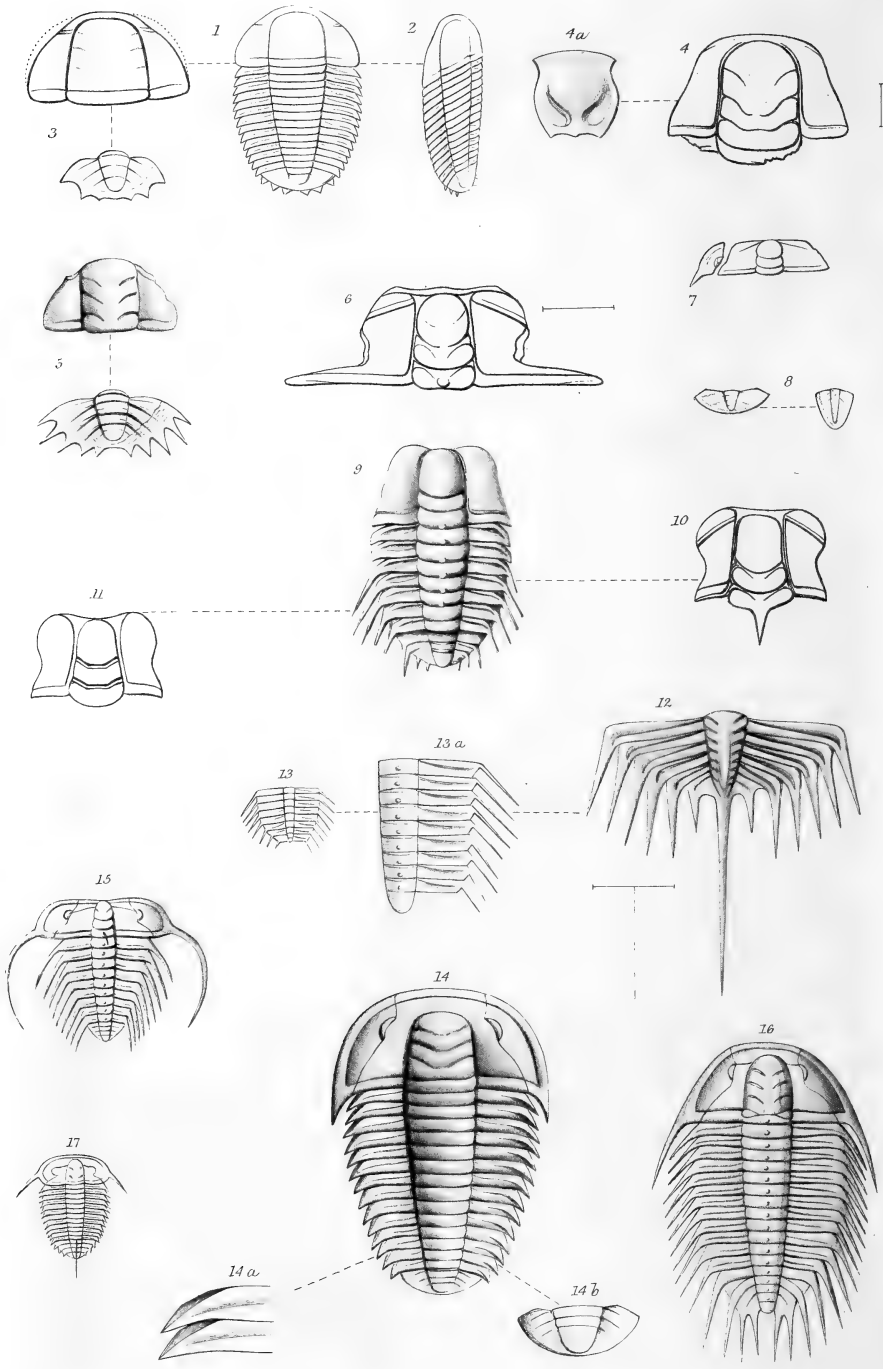
- Figs. 1-4. *Angelina Sedgwicki*, Salter, in various states of compression, according to the position in the slaty beds. (Mus. Pract. Geol.)
- Fig. 5. Labrum of ditto in Mr. Homfray's cabinet. Upper Tremadoc, Garth Hill, opposite Portmadoc.
- Fig. 6. *Conocoryphe invita*, Salter. Upper Lingula Flag, Penmorfa Church, Tremadoc, N. Wales.

J. W. SALTER.

November 1864.







Figs. 1, 3 OLENUS SCARABÆOIDES, Wahl. Figs 7-8 OLENUS FLAGELLIFER, *Angelin?*  
 4 ——— SP. 9, 11 ——— HUMILIS, — Phillips.  
 5 ——— SERRATUS, — Salter. 12, 13 ——— PECTEN, — Salter.  
 6 ——— BISULCATUS, Phillips. 14 ——— CATARACTES, — id.  
 Figs. 15, 17 are Swedish species for comparison.



# BRITISH FOSSILS.

DECADE XI. PLATE VIII. FIG. 14.

## OLENUS CATARACTES.

[Genus *OLENUS*. DALMAN, in part. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Olenidæ.) Glabella oblong, or usually narrowed anteriorly, lobed; eye smooth, with a narrow prominent ocular ridge (*Costula facialis*, Angelin) connecting it with the upper part of the glabella; facial suture marginal in front, and cutting the posterior margin behind; cheeks spinous, no rostral shield; hypostome? labrum oblong, narrowed at base; pleuræ 7-15, (14 typically), pointed and curved; tail with articulated axis and sides.]

[British sub-genera. *Olenus*, DALMAN. Body rings 11-15, head semicircular, spines moderate, tail entire.—*Sphærophthalmus*, ANGELIN (including *Eurycare*, id.) Body rings 7-15; head transverse, with remote eyes and widely curved long spines.—*Parabolina*, SALTER. Body rings 12; head semi-lunar; eyes approximate; spines diverging; tail spinose.—*Peltura*, ANGELIN (not Milne-Edw.). Body rings 12; head narrow, with approximate eyes, and no spines; tail spinose.]

DIAGNOSIS. *O. ovatus*  $1\frac{1}{2}$  *uncialis et ultra, capite magno semilunari, spinis brevissimis. Glabella sulcis tribus fere perfectis. Oculi antici. Thoracis axis latus, pleuræ vix recurvæ brevispinosæ, fulcro remoto. Cauda minuta, transversa, semicircularis, axi latissimo.*

Several species of the well-known *Olenus* of Dalman are now added to the British list. The originally described British form is *Olenus micrurus*, in our Decade II., plate 9 (1849), also "Siluria," 2nd ed., p. 45, foss. 4, fig. 2. That is not, however, by any means a common fossil, and it is necessary now to distinguish from it the present species, which appears to be the ordinary form in the lower black shales of North Wales.

*Description*.—Nearly an inch and a half long, ovate, blunt at both ends, the head wide, nearly one inch broad, the body much narrower, tapering regularly to the tail. The head is sub-truncate, the glabella moderate in size, parabolic, not so broad as the cheeks, reaching forward nearly to the narrow front margin, and about the width of that margin distant from it, furnished with three pairs of furrows, of which the lower two are complete across. The eye is nearly as far forward as the front of the glabella, and somewhat

rémote from it. The hinder angles of the head with the spines abrupt, short, scarcely reaching the fourth segment, directed backward, not outward as usual in the sub-genus.

Body rings 15 (our artist has only represented 14 rings), their axis convex, nearly as broad in all the rings as the pleuræ, which decrease regularly, not abruptly, in length from before backwards; they are obliquely pointed, with short spines directed outwards, but very little backward. The fulcrum of the pleuræ is placed beyond the half, even in the hinder rings.

Tail short, semi-oval, with a very wide axis, of three rings, and the sides with two furrows.

*O. micrurus* is easily distinguished from *O. cataractes* by the oblique lower glabella furrows, the shape of the small smooth sub-truncate tail, and by the abrupt narrowing of the hinder body rings, which also have the fulcrum placed nearer than half way out from the axis. The tail is even more easily distinguishable, the width of the axis being greater than that of the sides, and having three rings, including the terminal portion; there are two lateral furrows, not one only. *O. cataractes* has 15 body rings. *O. micrurus* 14.

The head is much like that of *O. micrurus*, but the lower glabella furrows run quite across. Compared with the Swedish *O. truncatus*, the greater breadth of the cheeks, and the longer, more parabolic form of the glabella, will distinguish it. I do not compare the caudal portions, for Angelin's figure looks as if there were some mistake in this part. Possibly two of the caudal rings as figured by him belong to the body, which otherwise would have but 13 rings—a difference hardly to be expected in such closely allied forms.

*O. truncatus* is, I think, from higher beds, at Andrarum in Scania, than our Lower Lingula flags, but this is a point not yet sufficiently investigated.

*Localities and Geological Position.*—LOWER LINGULA FLAGS, Maentwrog Waterfall, Merionethshire, in black shaly strata full of *Agnostus princeps*; also at Treflys, E. of Criccieth, Carmarthenshire N. Wales, where I found the figured specimen in 1859. Specimens probably identical are found at the Dolgelly gold mines.

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## OLENUS (SPHÆROPTHALMUS) FLAGELLIFER. ?

## PLATE VIII. FIGS. 7, 8.

SYNONYMS. *Sphæroph. flagellifer*, ANGELIN, Pal. Suecica, pl. 26, fig. 7. ? SALTER, Mem. Geol. Surv., vol. iii. ined. pl. 5, figs. 8, 9.

The only difference I can see between the Tremadoc specimens and the figure by Angelin is, that the glabella furrows in ours run quite across, while Angelin gives them as only lateral. But as this character of the complete transverse furrows seems to belong to the whole of the *Sphærophthalmi*, perhaps the Swedish artist has not sufficiently represented it. The other characters of the sub-genus (for it can, I think, only be so regarded) are the short and wide transverse head, the cylindric glabella reaching the front margin, and the very large curved head spines.

Again, *Eurycare*, Angelin, which I regard as only *Sphærophthalmus*, has a somewhat broader front, and wider and more parabolic glabella, thus leading from *Sphærophthalmus* to the true *Oleni*, of which *O. gibbosus* may be taken as the type. The characters seem to me not to be absolute in any of these sub-genera, and hence they may all, I think (and Barrande seems to be of the same opinion), be conveniently retained in *Olenus*.

*Description*.—Our specimens are so imperfect, that I do not pretend to give a true diagnosis, nor do I feel quite sure I have identified it rightly.

The head is very transverse and has parallel edges. The glabella is nearly square, and has only two pairs of furrows. The lower reach far across, and appear quite complete in some specimens; the upper, not represented in our scanty figure, only lateral and short. The ocular ridge is distinct and oblique. The margin very narrow. The neck segment also narrow. The free cheeks rotund, the eye large and prominent; the spine seeming to start from the outer edge above the angle. The thorax rings are strongly furrowed, their axis moderately broad.

The tail is entire, sub-triangular, with a conical axis, and furrowed sides. Our specimen shows no trace of a spine such as Angelin figures and describes.

I think the species is a distinct one, but in the absence of more complete materials, do not think it worth while to separate it from its near ally. Our figure is necessarily imperfect, but might have

shown more clearly the upper pair of glabella furrows and the outwardly placed head spines; the eye is also too small.

*Locality and Geological Position.*—UPPER LINGULA FLAGS, Carreg Wen, Borth, Portmadoc. (Mus. Pract. Geology.)

OLENUS (PARABOLINA) SERRATUS.

PLATE VIII. FIG. 5.

DIAGNOSIS. *O. modicus*,  $1\frac{1}{2}$ -uncialis, convexus. *Glabella oblonga æquilata, haud parabolica, anticè subtruncata, sulcis utrinque binis longis fere medium glabella attingentibus, paullo obliquis. Sulcus cervicalis vix continuus. Oculi valde antichi. Genæ angustæ. Cauda (hæc haud dubiè referta) semicircularis axi prominulo 4 costato, obtuso; lateribus utrinque 5-dentatis, dentibus patulis limbo brevioribus; hæc 4-sulcato, sulcis omnibus distinctè interlineatis.*

SYNONYMS. *Olenus (Parabol.) serratus*, SALTER, Mem. Geol. Surv., vol. iii. ined. pl. 5, figs. 6, 7.

*Description.*—Glabella quite as wide in front as behind, with a broad neck segment, equal in breadth to the basal lobe. The second or middle lobe somewhat narrower. Fixed cheeks broad, sub-trigonal, equal to more than half the width of the glabella, the eye placed very far forwards, opposite the forehead lobe. Free cheeks not known, probably narrow.

Tail, most likely of the same species, semicircular, serrate, with short, somewhat radiating spines. Axis thick, of four prominent rings and a blunt terminal piece; sides four-ribbed, the ribs duplicate, and produced on the margin into strong spines of less length than the limb, five on each side, the fifth pair of spines being set rather wide apart beneath the axis.

*Affinities.*—I much wish I could identify this with the common *O. spinulosus*, Wahl., for the head is very like. But the caudal shield is decidedly different, and as it in all probability belongs to the same species as the head, I feel bound to keep the two distinct. The glabella, moreover, differs, as above described, from that of the true *O. spinulosus*, which tapers a little forward. In that species the tail spines also are greatly lengthened.

*History.*—The section *Parabolina*, regarded as a genus by Angelin, was proposed by me in 1849 to distinguish the species of *Olenus* which have 12 body rings and a laciniate tail. *O. scarabæoides* might perhaps belong to this sub-genus as so defined, but

it has 13 body rings, and clearly belongs to a different natural group, in which the cheeks are much contracted, and the glabella enlarged; in the majority of *Oleni* the reverse is the case.

I believe Angelin has good reasons for supposing there are several distinct genera included under *Olenus*, but I do not quite see the way to their definition yet. The term *Peltura* can only stand by courtesy, for it was founded on a species of *Lichas*, as may be seen by reference to Capt. Fletcher's description of the British Upper Silurian species of that genus.\*

*Locality and Geological Position.*—UPPER LINGULA FLAGS, Carreg Wen, Borth, Portmadoc.

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OLENUS SCARABÆOIDES.

PLATE VIII. FIGS. 1-3.

SYNONYMS. *Vermiculites vagipennis*, BROMELL, in Act. Lit. Upsal., 1729, pp. 525, 528, cum icone. *Entomostracites scarabæoides*, WAHLENB., Nova Act. Soc. Upsal., vol. viii. t. 1, f. 2. *Olenus scarab.*, DALMAN, Palæadæ, p. 257. *Olenus scarab.*, HISINGER, Lethæa Suecica, t. 4, f. 4. *Paradox scarab.*, BRONGNIART, Crustaces, foss. p. 34, t. 3, f. 5. *Peltura scarab.*, MILNE-EDW., Crustaces, vol. iii. p. 344 (1840). *Peltura scarab.*, ANGELIN, Palæont. Suecica, pl. 25, f. 8 (mala), 1855. [*Olenus spinulosus*? PHILL., Mem. Geol. Surv., vol. ii. pt. 1, pp. 55, 239.] *O. scarab.*, SALTER, Siluria, 2nd ed., Appendix, p. 540. *O. scarab.*, Id., Mem. Geol. Surv., vol. iii. ined. pl. 5, figs. 2-5.

In size, as well as form, these pressed and distorted Trilobites agree pretty well with Christiania specimens presented by Dr. Th. Kjerulf to the Mus. Pract. Geology. But ours show only one ring to the axis of the tail besides the terminal lobe. Wahlenberg's fossil has two rings to the axis. The marginal spines are only clearly seen in one British example; they do not differ from the Swedish species except in being shorter (see fig. 3). The glabella in our specimens is broader, and the lobes less distinct. It is manifest, therefore, that there are sufficient differences to render it probable that better specimens will require us to distinguish it. I shall at present call it—

*Var. OBESUS.*

The following characters appear to me to be constant, and I find them both in N. Welsh and Malvern specimens.

\* Quart. Geol. Journ., vol. vi. p. 235.

General form broad oval, seldom reaching in length above an inch; of this the head occupies fully one-third. It is semi-oval, without the fixed cheeks (fig. 1), but with them (and perfect heads in Mr. Edgell's collection show them well) it becomes transverse-oblong. The broad parabolic flattened glabella is more than equal to the width of the cheeks, and has usually straight sides, sometimes in Malvern specimens a little contracted in the middle (fig. 4). Lobes very slightly marked (our fig. 4 has them too strong). The neck segment enlarged at the sides, and quite distinct across. The three pairs of furrows obscure. A very narrow margin in front of the glabella. The fixed cheeks narrow triangular, the eye very far forward, and connected with the front of the glabella by a low ocular ridge. The neck-furrow on the cheeks very near the hinder margin. Free cheek semicircular, very convex on its outer edge, and with a strong but narrow margin, and no spine, the base loosely contracted.

Labrum (fig. 4 *a*), in a Malvern specimen lent by the Rev. W. Symonds, squarish, urceolate, with the base not expanded, the sides convex, the apex broadly truncate; the lateral furrows oblique, broad, not deep.

Body rings 14 (in a specimen lent by Mr. Ash, fig. 1). But this number is somewhat doubtful, as I find my notes say it has only 12 distinct ones. The Swedish fossil has 13, according to Angelin's figure, but his description gives 12, probably the true number. Ours do not show a central tubercle.

Tail semicircular, with broad blunt axis, showing one distinct ring, and a larger terminal portion. The sides as broad as the axis, and with three obscure furrows, the margin distinctly tridentate on each side, with short spines, not much projecting beyond the border, which is not at all marginate.

I believe we may safely identify with this the small species found at Malvern (pl. 8, fig. 4), and described by Phillips under the name of *O. spinulosus*. We have copied his figure, Mem. Geol. Surv., vol. ii. pl. 1, p. 55. It is certainly not Wahlenberg's species of that name. The furrows of the glabella are far too plainly marked in our figure, but the slight contraction visible on the sides of the glabella is correct for Malvern specimens.

Taking all the evidence together, I am inclined to think the British fossil distinct from the Swedish; and I am principally indebted to Mr. Edgell for the specimens which lead to this conclusion. I shall retain the name under which our fossil is usually

known till we have more complete evidence that the var. *obesus* is distinct as a species from the well-known Swedish type.

*Locality and Geological Position.*—UPPER LINGULA FLAGS, Carreg Wen, near Borth, and Penmorfa Church, both near Tremadoc, N. Wales. Abundant at Whiteleaved Oak, Malvern, in the UPPER LINGULA FLAGS (Black Shales) of that locality.

OLENUS (SPHÆROPH.) HUMILIS.

PLATE VIII. FIGS. 9–11.

DIAGNOSIS. *O. (Sph.) minutus*, capite angusto antice emarginato, pleuris 7, posticis solum spinosis, caudâ sexcuspidatâ. Glabella convexa angusta parabolica, sulco basali completo, reliquis obsolete, cervice spinoso. Genæ convexissimæ, oculis omnino posticis, magnis. Thorax 7-costatus, pleuris duobus anticis muticis, reliquis spinosis. Cauda brevis semicircularis, 6-spinosa, spinis externis majoribus.

SYNONYMS. *Olenus humilis*, PHILL., Mem. Geol. Surv., vol. ii. pt. 1, pl. 55. SALTER, Mem. Geol. Surv., vol. iii. ined. pl. 5, fig. 12.

This minute species is well characterized by its very narrow instead of wide cheeks. Yet in other respects it is a perfect *Sphærophthalmus*, and such a copy in miniature of the *Olenoid* type, with nearly all the characters exaggerated or reduced, as to show us that great variation is to be found within its limits, and to induce us to regard the various groups into which *Olenus* has been divided as sub-genera rather than distinct generic types.

*Description.*—A minute form, not above a quarter of an inch in length, and of an ovate shape; the head broadest, as usual in this sub-genus, but rather squarish-oblong, with an emarginate front, the very convex cheeks projecting on either side so much forward as to bring their greatest convexity in advance of the narrow parabolic glabella! The facial suture follows this convexity in a sigmoid line, cutting the front margin at a short distance outside the axial furrow, then curving outwards widely, and then again at the lower third much contracted inwards to the place of the eye, which is near the base of the cheek. The eye-lobe which covers it is elevated and easily broken away, being divided by a deep furrow from the fixed cheek.

The eyes are large and round, and placed quite at the base of the free cheeks, which are true semicircles, strongly margined, and completely contracted to a point behind, showing (so far as I can see)

no trace of the curved spine characteristic of this sub-genus. Our figured specimens had not the free cheeks in any case. Mr. Edgell's specimens show them well.

Body short, of seven rings only,\* with a broad axis, showing in the five front rings the central tubercle. The pleuræ are short, strongly grooved; the two front ones without recurved spines, the rest spinous; the spines bent strongly back and about as long as the pleuræ.

The tail is nearly a semicircle, and furnished with a strong conical three-ribbed axis, which reaches the end. The sides two-ribbed, with three spines on each side, the forward one longest, the other two short, and leaving a rather broad smooth space at the extremity of the tail beneath the axis.

*Locality and Geological Position.*—Only known in the BLACK SHALES of Malvern, Fowlet's Farm, and Whiteleaved Oak Farm, &c., and very abundant there, with other species of the genus next described.

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OLENUS BISULCATUS.

PLATE VIII. FIG. 6.

DIAGNOSIS. *O. (Sph.) modicus, capite transverso, glabellâ bisulcatâ, genis latissimis. Thorax pleuris latis, profunde sulcatis, spinis validis rectis.*

SYNONYM. *O. bisulcatus*, PHILL., Mem. Geol. Surv., vol. ii. pt. 1, p. 55, fig. 1.

The head of this species is remarkably wide, and thus differs at a glance from *O. humilis*, with which it occurs. The body rings have lately been detected in the cabinet of my friend, Mr. Edgell, and I am thus enabled to improve the description. The species is stouter in all its parts than is usual in the sub-genus.

The species is a small one, not more than eight lines in length, and the width from tip to tip of the stout thorax spines seven lines. The head is very transverse, three times as wide as long, even excluding the free cheeks, which we do not perfectly know, but believe to have extended somewhat further out, and to have been armed with a stout curved spine starting one third or thereabouts above the genal angle. The front is straight, or only slightly emarginate, and the

\* The species is abnormal for the genus, abnormal even for the sub-group to which it belongs. It contradicts most of the technical characters of *Olenus*, and yet evidently belongs to it.



margin narrow, the long sub-cylindrical glabella touching it. The axial furrows are deep; the glabella narrower forwards and rounded in front, with a strong neck-lobe, not spinous but with a central tubercle, a pair of complete basal grooves cutting off the lower third of the glabella, and an incomplete upper pair.

The fixed cheeks consist of an oblong convex plate in front of the eye, which is placed far back, opposite the basal furrow, and about the width of the glabella apart from it. The ocular ridge is very oblique, and only reaches the front edge of the broad eye lobe. The facial suture is sinuous, but nearly vertical to the eye, and beneath it turns abruptly outwards in a line all but parallel to the neck margin, and reaches it at a distance from the glabella equal to twice the width of that organ. The neck furrow is narrow, but distinct all along.

[The cheek, in a separate specimen of Mr. Edgell's probably belonging to this, is a quadrant of a circle, with a round prominent eye, and a narrow margin on the outer edge. The spine starts considerably above the angle, and on the level of the eye, and appears to be short and not much curved.]

Thorax of — ? rings. We have only six preserved; they are broad, straight, equal in width to the axis, excluding the strong patent spine, which bends very little backward, and is about as long as the pleuræ themselves. The pleural groove is deep and broad, and reaches the base of the spine. The axis is convex, and has a spinous tubercle on each segment.

*Locality and Geological Position.*—UPPER LINGULA FLAGS, Whiteleaved Oak, Malvern. (Mus. Pract. Geol.)

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OLENUS (SPHÆR.) PECTEN.

PLATE VIII. FIGS. 12, 13.

DIAGNOSIS. *O. parvulus monstrosus, capite contracto longispinoso, thorace multispinoso, caudâ mirâ pectinata et in spinam longissimam centralem producta. Caput ad frontem emarginatum, glabellâ brevi, genâ angustâ spinam medianam curvam gerente. Oculis omnino antrorsis. Thorax pleuris rectissimis, spinis aciculatis. Cauda spinis utrinque sex parallelis, et medianâ longissima.*

Oblong, the head contracted in width, emarginate in front, with narrow glabella, and furnished with convex projecting cheeks,

bearing very forward eyes. They are placed on the most prominent part of the cheeks, opposite the front of the glabella, and about midway from it. The fixed cheek is wider than the glabella, but the free cheek is not so wide, and much resembles that of *O. humilis*. And the facial suture, as in that species, is nearly vertical below the eye as well as above it.

The head-spine does not in this species start from nearly the base, but quite up in the middle of the free cheek. It is only slightly curved; but arising from so unusual a position, it has a most odd appearance. It reaches to the seventh thorax ring.

The thorax-rings are much wider than the head, and remarkably straight across. The axis is not above one-third the width of the straight pleuræ, which are even a little curved upward, and grooved throughout; they bear a straight spine, directed obliquely backwards, and longer in the hinder segments. We only know seven rings; there must have been several more.

Mr. Turner, schoolmaster at Pauntley, Gloucestershire, was the discoverer of this curious species, and sent it to the Rev. W. Symonds. It has since occurred in greater plenty. Mr. Edgell has perfect heads and several caudal portions. The Rev. T. B. Brodie has an excellent specimen.

*Locality.*—With the preceding.

The group of species last described rather fully illustrate the curious sub-genus *Sphærophthalmus*, and show how wide in these ancient genera the limits of variation are in a single group. As we ascend in the geological scale, the law of variation becomes more restricted, and characters which are of family value in the more advanced groups scarcely afford generic distinctions in some of the more ancient and less highly organized ones.

The *Olenidæ* and the *Asaphidæ* have both of them wide limits, and it may be possible by and by to subdivide them.

*Locality and Geol. Position.*—UPPER LINGULA FLAGS, White-leaved Oak, Malvern.

#### FIGS. 15, 16, 17.

I have figured the Swedish *O. spinulosus* (fig. 16,) to give the British student an idea of what form to look for when searching for fragments of *O. serratus*. Fig. 15 illustrates perfectly the sub-genus *Sphærophthalmus*, while it is also a common Upper Lingula Flag fossil for Britain (see Mem. Geol. Surv., vol. iii. ined., pl. 4). Fig. 17 is Angelin's sub-genus *Leptoplastus*, which I regard as a form of *Sphærophthalmus*, and may illustrate in part our *O. pecten* and *O. flagellifer*. *Olenus* proper and *Peltura* are sufficiently represented by our own species.

## OTHER BRITISH SPECIES.

- O. micrurus*, Salter, Decade II., pl. 10, (section *Olenus*).  
*O. alatus*, Bæck, our pl. 8, fig. 15, and Salter in Mem. Geol. Surv., vol. iii. ined., pl 4, fig. 3 (section *Sphærophthalmus*.)

## EXPLANATION OF PLATE VIII.

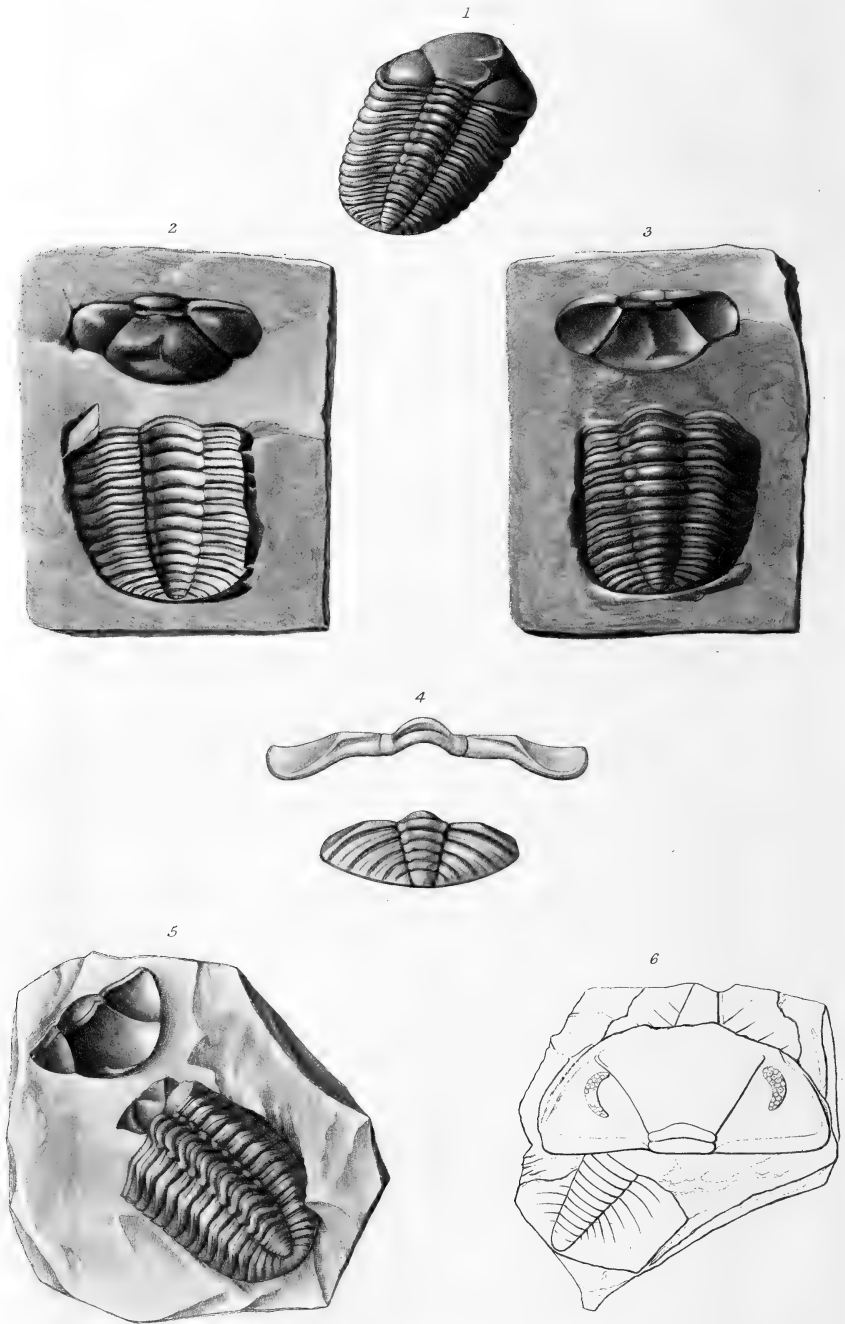
- Figs. 1-4. *Olenus (Peltura) scarabæoides*, Wahl.? (possibly a new species), var. *obesus*, Salter. Fig. 1. Natural size, uncompressed (Mr. Ash's cabinet). Fig. 2 compressed (Mus. Pract. Geology.) Fig. 3, slightly enlarged; specimens are, however, occasionally found nearly of these dimensions.
- Fig. 4. Malvern specimen, the same figured by Phillips in Mem. Geol. Surv., vol. ii., pt. 1, pl. 55. The glabella furrows are far too strongly marked.
- Fig. 4 a. Labrum, from Malvern. Upper Lingula Flag (Black Shales).
- Fig. 5. *Olenus (Parabolina) serratus*, n. sp., Carreg Wen, Portmadoc.
- Fig. 6. *Olenus (Sphærophthalmus) bisulcatus*, Phill. His original specimen from Malvern, in Upper Lingula Flag.
- Figs. 7, 8. *Olenus (Sphær.) flagellifer*, Angelin.? Carreg Wen, Portmadoc, Upper Lingula flag.
- Fig. 9. *Olenus (Sphær.) humilis*, Phill., Malvern. Dr. Grindrod's cabinet (magnified).
- Figs. 10, 11. Heads of the same (the free cheeks lost). Same locality. (Survey collection.) Abundant in the Black Shales.
- Fig. 12. *Olenus (Sphær.) pecten.*, n. sp. Same locality. (Rev. W. Symonds' cabinet.)
- Fig. 13. Thorax of do., natural size and magnified. Same locality and cabinet.
- Fig. 14. *Olenus cataractes*, n. sp., Lower Lingula Flags, Treflys, near Criccieth (Mus. Pract. Geol.) 14 b. Tail enlarged. 14 a. Pleuræ.
- We have figured three Swedish fossils to illustrate sub-genera imperfectly represented by British specimens. All are from the primordial zone.
- Fig. 15. *O. (Sphær.) alatus*, Bæck, copied from Angelin.
- Fig. 16. *O. (Parabolina) spinulosa*, Wahl. do.
- Fig. 17. *O. (Leptoplastus)* or *Sphærophthalmus raphidophorus*, Angelin, copied from his Palæont. Suecica, pl. xxvi., fig. 2.

J. W. SALTER.

November 1864.







Figs. 1-5 PHACOPS (TRIMEROCEPHALUS) LAEVIS - Münster.

6 ..... CRYPTOPHITHALMUS. Emm. (from Sandberger)

# BRITISH FOSSILS.

DECADE XI. PLATE IX. FIGS. 1-5.

## PHACOPS (TRIMEROCEPHALUS) LÆVIS.

[Genus PHACOPS. EMMRICH. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Phacopidæ.) Eyes largely faceted; facial suture ending on the outer margin; thorax 11-jointed.]

[Sub-genus *Trimerocephalus*. Form compact. Glabella inflated and expanded or wards, the lobes, except the basal ones, obscure. Eyes very small, of few large lenses (often lost by abrasion) or absent. Head angles not spinous. Facial sutures soldered. Thorax with pleuræ all rounded. Tail small, of few segments, with even border, and not at all produced.]

DIAGNOSIS. *P. (Trim.) cæcus, latè ovatus lævis, glabellâ latissimâ, brevi, genas subsphericas trigonas superintendente; lobis basalibus minutis distinctis. Thoracis axis angustus, fulcro pleurarum axin approximato, sulcoque brevi. Cauda latissima brevis, axi longo, 5-annulato, lateribus 4-sulcosis, margini nullo.*

SYNONYMS. *Trinucleus lævis*, MÜNST. Beitr. Heft 5, t. x. fig. 6 (1842). *Calymene lævis*, PHILL., Pal. Foss., pl. 55, fig. 250 (1841), (not *Cal. lævis*, MÜNST., l. c. t. v. fig. 4). *Asaphus* or *Trinucleus*, SOWERBY, Geol. Trans., 2nd Ser., vol. v. pl. 57, fig. 30 (1840). *Trimerocephalus lævis*, MCCOY, Ann. Nat. Hist. vol. iv. p. 404, woodcut (1849). Ibid, Synopsis Woodw. Mus., p. 178 (1851). SALTER, Palæont. Society, Monogr. (1864), p. 16, pl. 1, figs. 5, 6, 7.

It would perhaps be better if a new name were bestowed upon this species. It is clearly enough the *Trinucleus lævis* of Münster, and that fossil belongs to *Phacops*. But the *Phacops (Calymene) lævis* of Münster is quite another thing, and typical of another section of the genus; and if the latter were a good species, and not a mere synonym of *P. granulatus*, as I believe it to be, it would be imperative to change the name, and I would then propose the term *P. trinucleus* for this species. At present it had better stand as *P. lævis*.

There is less difficulty about the name of the sub-genus. That bestowed by McCoy is convenient enough, the group being a really good one, distinguished by the soldered head sutures and especially the absence of eyes.\* No trace can be seen of these organs in the present species.

*Description.*—Rarely exceeding an inch and a quarter long, of a broad oblong-oval shape, the head being nearly one-third the whole length, convex, and divided deeply into three tumid lobes, of which the lateral ones or cheeks are not above half the width of the glabella. This is “sub-rhomboidal,” or spherical-triangular, convex, smooth, twice as broad in front as behind, where a very narrow pair of basal lobes separates it from the neck-ridge; the upper furrows are quite obsolete. The cheeks are trigonal, the shortest side being the outer or marginal side, very evenly convex, and with no trace of an eye. They are bordered by a very distinct and rather broad smooth margin, which is continuous at the rounded posterior angles of the head, and lost in front, where it abuts against the glabella.

Thorax of 11 segments, with convex narrow axis and rounded pleuræ; the segments of the axis tuberculate at the sides; the pleuræ not much bent back, rounded at the end, the groove narrow and short, the fulcrum placed at less than half way out; the facet rather large.

The tail is short and broad; its length not half its breadth, and both forward and hinder edges being curved, so as to give a lenticular outline. The axis is suddenly narrower than that of the thorax, conical and gently convex, attaining very nearly the border of the tail, blunt at the tip and marked with four or five transverse furrows. The sides have four radiating bent furrows, which are faintly interlined and nearly reach the edge; there is no distinct border to the tail.

The species was first figured in England (from the only English locality I know of, viz., the Knowl Hill, near Newton Bushell,) in the plates executed by Sowerby for the Devonshire Memoir of Professor Sedgwick and Sir R. I. Murchison.† That figure is from

\* *Trimerocoelus* has been lately made to include all the species with lobeless or very faintly lobed glabella and soldered sutures and superficial minute eyes, e.g., *Phacops Volborthi*, Barrande, and *P. cryptophthalmus*, Emrich, which last is figured on our plate for comparison. But it will probably be hereafter restricted to the present species and kindred forms, since the most careful scrutiny fails to detect the least trace of eye or facial suture.

† Trans. Geol. Soc., 2nd series, vol. v., 1840.



an uncompressed specimen, but they are mostly distorted, and, as noticed by Mr. Pengelly, the head is generally disjointed from the body and inverted, as if the animal had habitually kept it bent under, and been preserved in the slate in that position. In that posture, and exposed to the accidents of slaty cleavage, it is often difficult to distinguish the parts correctly; and the juxtaposition of two specimens, or the extra elongation along the line of cleavage, have often given rise to a specimen with apparently more than the proper number of body rings, and to all sorts of abnormal proportions of the various parts.

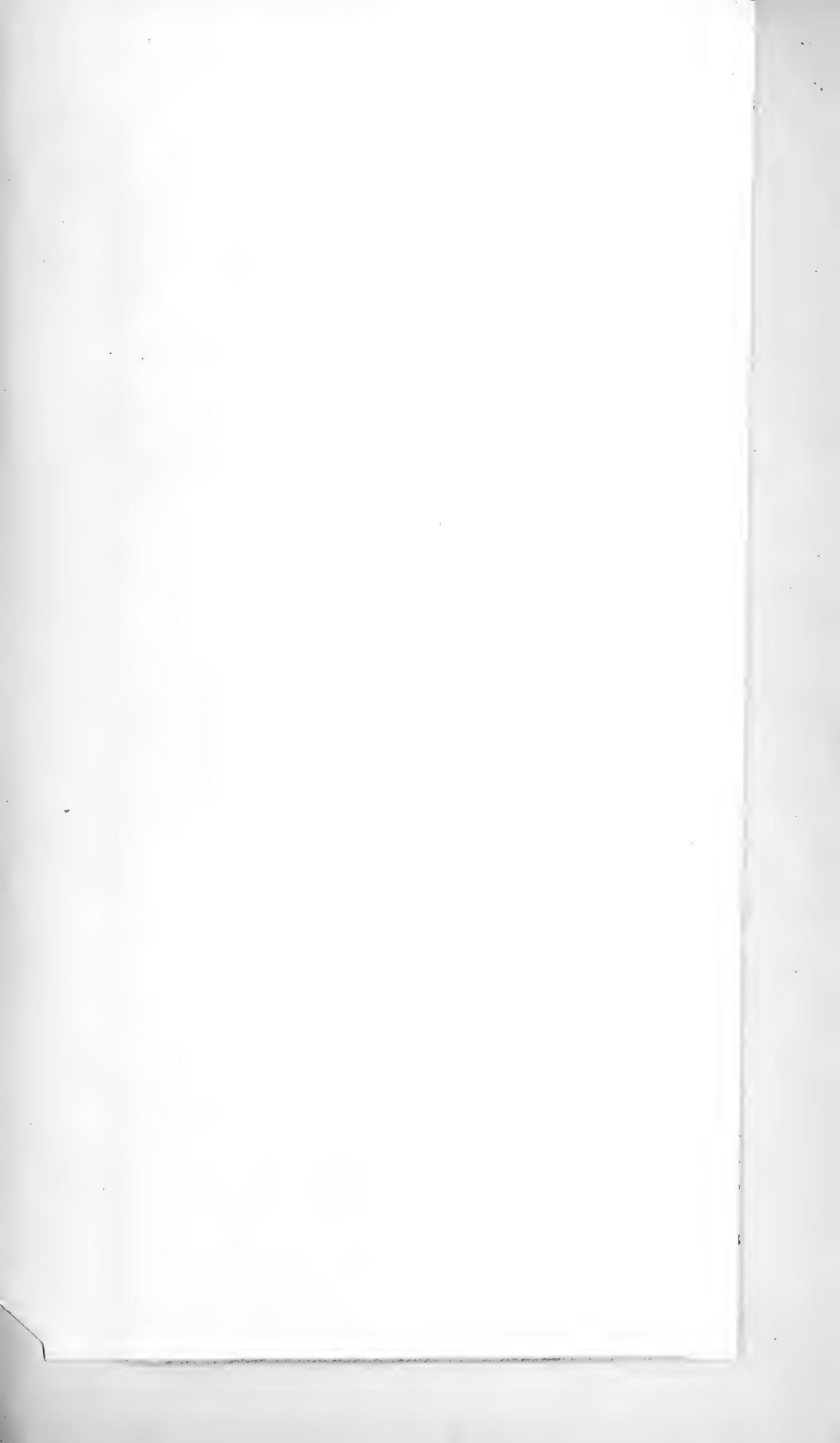
*Locality and Geological Position.*—UPPER DEVONIAN. Knowl Hill, Newton Bushell. It is quoted by Phillips from S. Devon, at Mudstone and Durlstone Bay. I think there is much doubt of these *Lower Devonian* localities, but less doubt about Brushford, N. Devon, in the Marwood or Pilton group.

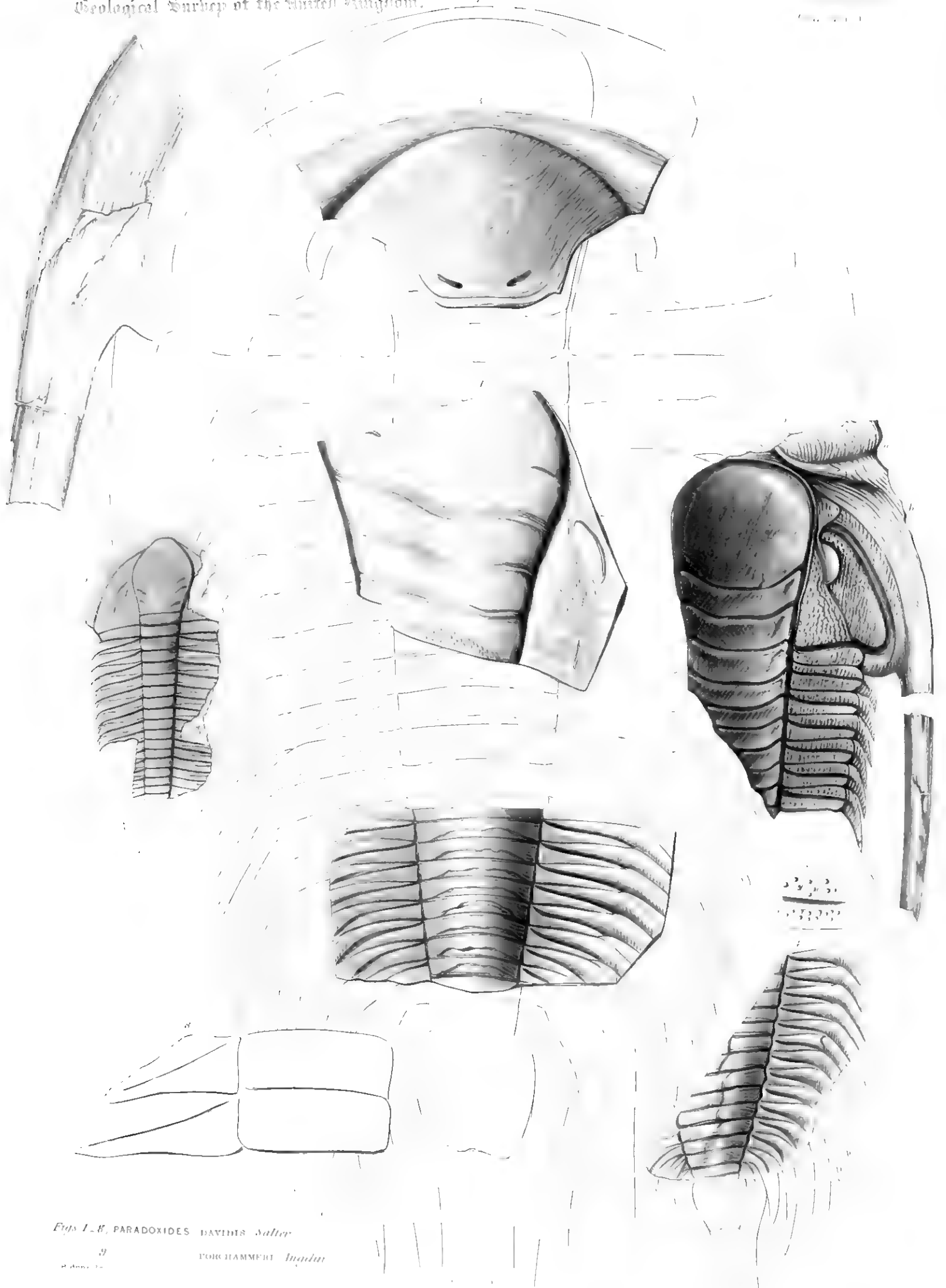
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EXPLANATION OF PLATE IX.

- Fig. 1. *Phacops (Trimerocephalus) lavis*, Münster. Specimens from Knowl Hill, Newton Bushell. (Mr. Pengelly's cabinet.)
- Figs. 2, 3. From the same locality and cabinet. Specimens in which the head has been disjointed from the body and reversed in position. (See also fig. 5.)
- Fig. 4. Thoracic ring and tail from Mr. Vicary's cabinet.
- Fig. 5. Original specimen figured by Sowerby in the Geol. Trans., 2nd series, vol. v. (Same locality.)
- Fig. 6. *Phacops (Trimeroc.?) cryptophthalmus*, Emmer., from Nassau. Copy of Sandberger's figure to show the differences of the species. *P. cryptophthalmus* is often confounded with *P. lavis*.







Figs 1-8, PARADOXIDES DAVIDIS Salter

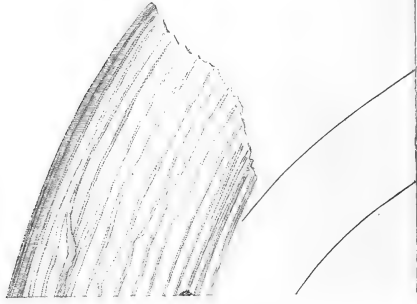
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FORHAMPTON *tridac*

Plate 10



Geological Survey of th



# BRITISH FOSSILS.

## DECADE XI. PLATE X.

### PARADOXIDES DAVIDIS.

[Genus PARADOXIDES. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Olenidæ.) Elongate, of many segments, with a broad head and spinous head-angles, often greatly extended. Glabella widely clavate, with the lower furrows complete across. Labrum soldered to the hypostome. Body rings flattened, 17 to 20 in number, produced into recurved spines. Tail small, of few segments. Range, primordial zone only.]

DIAGNOSIS. *P. sesquipedalis et ultra, maximus, glabellâ parum clavata, genis latiori, sulcis duobus solum perfectis, reliquis obsoletis. Oculi antrosum positi. Thorax articulis 19, axe lato. Pleuræ subrectæ, apicibus recurvis; anticis brevissimis abrupte flexis, ultimis longissimis, fere parallelis. Cauda truncata, axi obscuro 2-3 annulato; gladiis laterilibus longissimis.*

SYNONYMS. *Paradoxides Davidis*, SALTER (1863), Quart. Journ. Geol. Soc. (1864), vol. XIX., p. 275, woodcut, and XX., pl. 13, fig. 1-3.

The genus *Paradoxides*, from its bulk, has necessarily attracted attention from the earliest times in which fossils have been observed and collected. Linnæus figured it, from Sweden, and Count Kinsky from Bohemia, in the 18th century, and the *Entomostracites paradoxissimus* was still the name under which Wahlenberg noticed it in his résumé of the Swedish Trilobites in 1821. Brongniart added to the typical form several species afterwards known as *Olenus* by Dalman, who did no more than uselessly change the name of the whole genus. And while the species were distinguished by subsequent observers, the new name *Olenus* seems to have been adopted till Bronn, in 1835, restored that which Brongniart had imposed. Zenker, in 1833, had suggested a division of this large genus, making the great *Paradoxides* the type of *Olenus*, and so reversing the original nomenclature. But Emmrich's essay did not second this idea, and it was left for Goldfuss, in his systematic review of the group (Jahrbuch, vol. v., 1843), to give their correct definition to these two genera, which have since been generally adopted.

The broad club-shaped glabella, large head spines, and numerous

(17 to 20) segments to the body, easily distinguish this group, which comprehends the largest Trilobites known, and yet is the earliest or nearly the earliest type of the whole Trilobite family. *Agnostus* accompanies it in all countries where it has been observed, and it is known to have ranged from N. America to Russia, and from Sweden to Spain and Bohemia. Twenty years ago a single specimen was found in the British slate rocks, and it is only within the last year or two that it has been found in any considerable numbers, in a single locality in South Wales. I had myself the good fortune to discover the new species, which was first figured in the Quarterly Geological Journal for 1863.

*Description.*—Of the head we have now many specimens, and some of the fragments betoken a fossil not less than 16 or 18 inches long; one or two heads are perfect, and show that it was semi-circular, with very large, thick, cylindrical, and tolerably straight spines. The glabella rather long, reaching and overhanging the front margin, broader but not suddenly so in front, half its length being occupied by the great front lobe.

There are obscure traces in some specimens of short anterior furrows, but I cannot be sure of more than the two complete posterior ones, which bend backwards in the middle, and are equally strong with the neck furrow. The eye is far forward, in advance even of the second or upper glabella-furrow, and is near the glabella,—not half its length distant from it. The cheek is coarsely granular, except toward the outer angle, and abruptly contracted beneath, at the base of the great cylindrical spine.

The labrum is expanded at the base, and has a truncated end, with sub-spinous lateral angles. It is, as usual, separated by scarcely any suture from the hypostome, or rather is connate with it.

I can, in a fine specimen lately found, count 19 body-rings, and believe this to be the full number. The axis is very wide (in the largest specimen  $1\frac{1}{2}$  inch) and convex, fully as wide in front as the pleuræ, spine included, and so for the eight or nine front segments. The apex of the pleuræ in these is abruptly turned back, with a short sharp mucro, and there is no enlargement of the second or third pleura—a character of importance in this genus. All have a deep groove, which is considerably oblique, and reaches the hinder margin just at the base of the spine in all the pleuræ. But from the eighth or ninth segment the pleuræ lengthen, and the axis gradually tapers. The hindermost axial ring is about half the width of the front ones, and scarcely one-fourth as wide as its long pointed pleuræ.



All the middle pleuræ have a strong curve backwards from the fulcral point, but at the same time arch outwards, and gradually, as they approach the tail, close in upon it until the hindermost are parallel with it. These hinder pleuræ are greatly lengthened, and are of two forms in two distinct varieties (possibly sexes?). In one form (fig. 4) the penultimate pleura is developed into a shorter spine than the preceding; and the last is suddenly abbreviated and incurved. This may be by abortion of the segments. In another the increment is regular, but the last spines are not extravagantly developed. In a third variety, the ultimate and penultimate pleuræ are greatly extended (fig. 7), and this is accompanied by a corresponding dilatation and lengthening of the caudal portion next to be described.

The tail in this species is most remarkable, and for some time I was inclined to believe that its outer segment was the ultimate pleura of the body. In fact, the front caudal ring is a very slightly metamorphosed body-joint, and is not very strongly connected with the tail piece; but it nevertheless belongs to it.

Exclusive of the great sabre-shaped lateral spines, which are three or four times its length, the tail is an oblong convex plate, with a short conical broad axis occupying about two-thirds of its length, and annulated by two or three incomplete rings. The extremity of this plate is broad and sharply truncate, contrasting with the parabolic contour of its axis, which is not so long as broad. The sword-shaped appendages are broader as well as longer than the last pleura of the body rings, and at first bend strongly inwards beneath the tail, afterwards diverging again at the tips (fig. 4). In one variety they are, in a moderate sized specimen, four inches long. They are connate with the central plate of the tail, though separated from it by a deep groove, except at the actual base, where the character of a pleura is maintained by the usual pleural groove running out into it.

The nearest approach to this structure is made by the *Paradoxides Bohemicus*. But in that species the enlarged last appendages are true pleuræ, according to Barrande's figure, and the tail itself is destitute of all appendages. Moreover, in that allied species the second pleura of the body is enlarged; so we have an additional character of separation from the present species.

In *P. spinosus*, Boeck, the glabella is shorter and the eye less curved and nearer the glabella. The unfurrowed portion of the pleuræ is shorter, and the hinder pleuræ are only straight, not sinuous.

*Paradoxides Davidis* nearly equals in dimensions the great *P. Harlani* from Massachusetts, and exceeds the large Newfoundland species described by me under the name of *P. Bennetti*.\* The three Swedish species are greatly inferior in size.

The above description is chiefly taken from the Quarterly Geol. Journal for the present year. In the plate accompanying that Memoir all the varieties are figured.

*Locality and Geological Position.*—LOWEST LINGULA FLAGS, Porth Rhaw and Solva Harbour, both near St. David's, South Wales. It has been lately detected at the Dolgelly gold mines, close to Pistyl-y-Cain, by Mr. Readwin, and by Mr. Ezekiel Williamson, an excellent observer.

P. FORCHHAMMERI. ?

PLATE X. FIG. 9.

SYNONYMS. *Paradoxides Forchhammeri*, ANGELIN, Palæontologia Suecica, t. 2 ? *Paradox. Forchhammeri*, SALTER, Siluria, 2nd ed. 1859, p. 45 ; Foss. 5, fig. 2, ib. ; Mem. Geol. Surv., vol. iii. ined., pl. 4, fig. 12.

*Description.*—Our specimen must, when perfect, have been fully  $3\frac{1}{2}$  inches long by  $1\frac{1}{2}$  broad. Of this length the long head is fully one inch, semi-oval, and with a long clavate glabella, which reaches quite to the front, and is rather broader than the cheeks. Below, the glabella is sub-linear, and not much above half as wide as in front. And it appears to have only the two lower complete transverse furrows ; the upper inflated portion, more than twice the length of the lower, being unmarked by any furrows, except a pair of very short ones marking the place of the middle lobes.† The eye is larger and placed further back on the cheek. The border of the head distinct and broad. Spines — ? (the outer angle of the cheek is lost, and we do not know what the spines may be).

Body with a long cylindrical axis tapering very slowly backwards, with straight sides. The axis-rings are not, even in the front part, more than thrice as wide as long, and at the twelfth ring not so much. We have only 15 of the body segments, and the pleuræ are equal and similar for the first eight rings at

\* Quart. Journ. Geol. Soc., vol. xv. p. 553.

† Two pairs are marked out in the figure in Siluria above quoted. But there is hardly any warrant for this. The specimen is too imperfect to decide it fully.

least, the second or third not being at all visibly enlarged at the end.\*

The pleuræ are wider than the axis by one-fifth, or less, and are but slightly curved, the tip acuminate, short, recurved, but not produced as in *P. Davidis*. We have only eight pleuræ, and cannot therefore determine the shape of the extremities of the hinder ones. But there is no appearance of enlargement in the seventh or eighth. The groove is very oblique, and runs into the short mucro, rather than ends abruptly behind its base. As M. Angelin's *P. Forchhammeri* wants the front body rings, and ours the hinder ones, it is not possible to institute a closer comparison.

Although very incomplete, enough remains to show that the species is distinct from any of the Bohemian ones, unless it may be *P. Bohemicus*, and from either of the three Swedish species described by Angelin, except *P. Forchhammeri*.

But there are several points in which it agrees with the latter species and differs from *P. Bohemicus*. The glabella is widely clavate, and the furrows across the base are parallel, or nearly so. The eye appears to be nearly in the right position, but this is obscure. The body rings, of which we have only 16 preserved, have the axis narrower than the pleuræ, and the latter have only short points, and very oblique grooves. The second pleura is not elongated, nor at all wider than the third, another point in which it differs from *P. Bohemicus*, but in which *P. Forchhammeri* does not offer means of comparison. But in the proportionate length to their width, the pleuræ agree much better with the Swedish species, the length being rather more than three times the width, while in *P. Bohemicus* it is rather less.

In both *P. spinosus* and *P. rotundatus* of Bohemia, and *P. Tessini* of Sweden, the two basal glabella furrows, besides the neck furrow, run quite strongly across. Our species does not need, therefore, comparison with them, as it has only one transverse groove above the neck furrow; the rest are very obscurely indicated in this specimen, which has been much compressed in an oblique direction. This will account for the narrow glabella.

*Locality and Geological Position.*—LOWER LINGULA FLAGS, North Wales (exact locality uncertain, probably near Dolgelly). Collected by A. Selwyn, Esq., 20 years back. (Mus. P. Geology.)

\* Usually Bohemian species have the second ring enlarged. N. American species the third pleura. In *Anopolenus*, an allied genus, the hindermost 3 or 4 are all enlarged.

## EXPLANATION OF PLATE X.

- Figs. 1-6. *Paradoxides Davidis*, Salter, various fragments from the Lower Lingula Flags of St. David's.
- Fig. 1. Large glabella, showing two complete furrows, and one incomplete pair (this last is doubtful), and other specimens do not confirm it.
- Fig. 2. Tolerably complete head, with the labrum, *a*, turned upward from the lower surface at *b*; the suture between the *labrum* and the *hypostome* is seen to be soldered.
- Fig. 3. Labrum of large specimen.
- Fig. 4. Hinder body rings showing the gradually lengthening points of the pleuræ, completed from more perfect specimens. (See Quart. Geol. Journ., 1864, vol. XX., pl. 13.) This variety has the last pleura abbreviated.
- Fig. 5. Posterior body rings.
- Fig. 6. (Not numbered on the plate.) Head spine of the largest specimen known. All the above, except fig. 2, are in the Mus. Pract. Geology. Fig. 2 is in the cabinet of Mr. J. E. Lee, Caerleon. The ornament of its pleuræ is seen in the magnified figure.
- Fig. 7. Outline, restored from the largest fragments, and nearly coinciding with the size of the largest and nearly perfect specimen since found, and placed in the British Museum.
- Fig. 8. Body rings of a very large individual. (Mus. Pract. Geology.)
- Fig. 9. *Paradoxides Forchhammeri*, Angelin? From the black Lingula flags of N. Wales, Locality unknown, probably Dolgelly. (Mus. Pract. Geology.)

J. W. SALTER.

November 1864.

MEMOIRS  
OF THE  
GEOLOGICAL SURVEY  
OF  
THE UNITED KINGDOM.

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*Figures and Descriptions*

ILLUSTRATIVE OF

BRITISH ORGANIC REMAINS.

—  
DECADE XII,  
—

ILLUSTRATIONS OF THE STRUCTURE OF THE  
CROSSOPTERYGIAN GANOIDS,

BY THOMAS H. HUXLEY, F.R.S.,

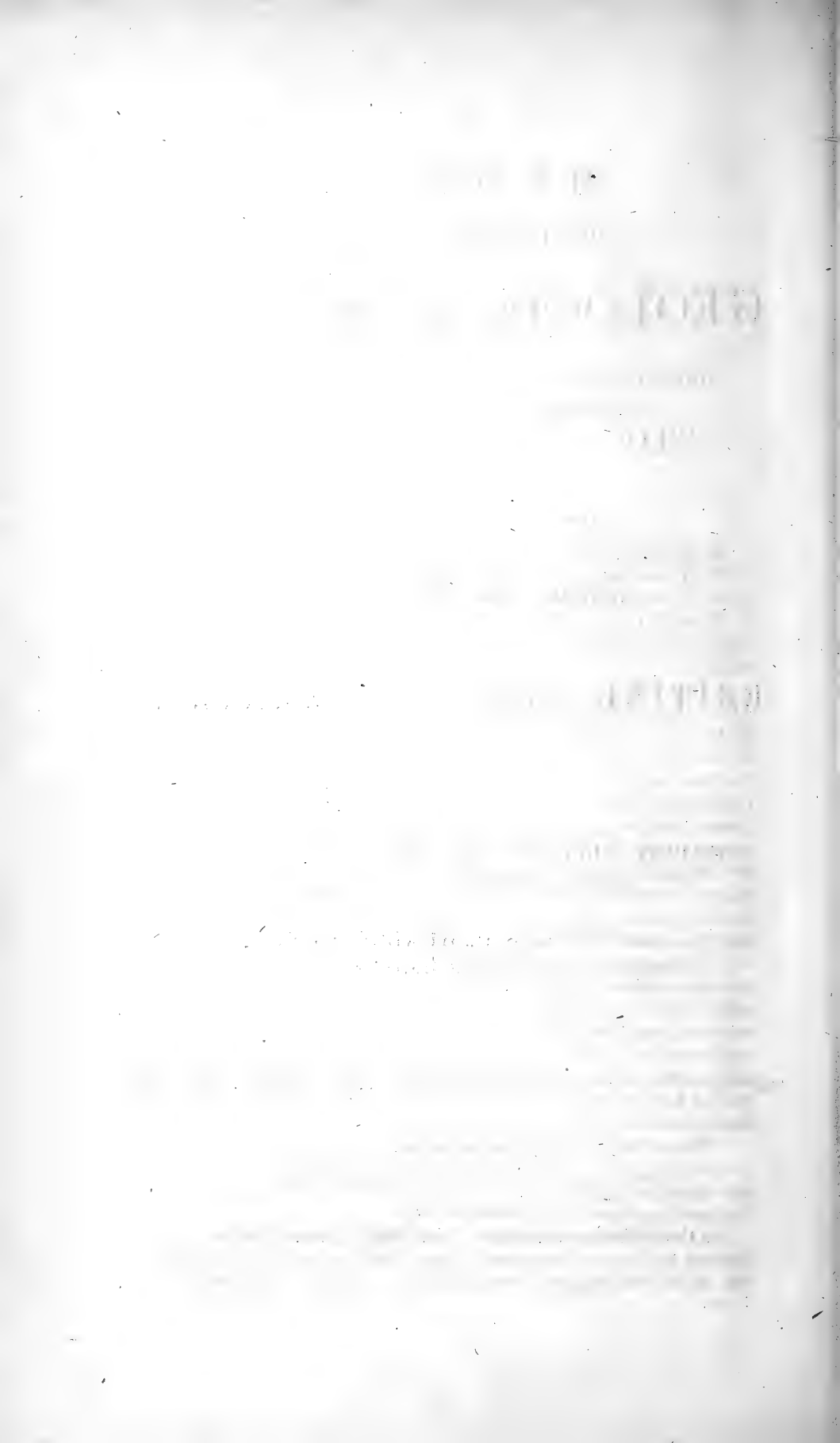
NATURALIST TO THE GEOLOGICAL SURVEY OF GREAT BRITAIN.

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1866.



# BRITISH FOSSILS.

DECADE THE TWELFTH.

## ILLUSTRATIONS OF THE STRUCTURE OF THE CROSSOPTERYGIAN GANOIDS;

BY

THOMAS H. HUXLEY, F.R.S.

### I.—THE GENUS GLYPTOPOMUS.

At p. 57 of the "Poissons Fossiles du Vieux Grès Rouge," Prof. Agassiz remarks, in establishing this genus, that he at first took the only specimen known to him for a *Platygnathus*; and it is figured in the 26th plate as *Platygnathus minor*. He describes the unique specimen of *Glyptopomus minor* in the following terms:—

"This fish, of which I know but a single specimen, obtained at Dura Den, and placed in the collection of Prof. Jameson, has the body wide and heavy, and resembling in form that of *Holoptychius*. It lies on its belly, and is turned a little to the left side, so that it is the back and right side which are visible. The head is proportionably small, and composed of enamelled and irregularly sculptured bones, which appear to be covered with a thick and very variable granulation. In the middle of the head it is easy to distinguish the frontals; in front, the nasals; behind, the occipital; and a great lateral enamelled plate, which indicates that the cheek was covered, as in *Polypterus*, by a single osseous lamella, below which the great masticatory muscle was fixed.

"The scales of the body are very considerable, very high on the sides, almost square on the back. They form oblique series, which meet at an acute angle in the middle line of the back. The scales themselves are very thick, placed side by side, apparently connected together only by the integument in which they were implanted. Their enamelled surface is not smooth, but adorned with a fine granulation, which gives them a velvety aspect. I have been unable to examine their microscopic structure.

"Only a few traces of fins are preserved in the specimen figured; probably a portion of the ventral near the throat, and a vestige of the dorsal, or caudal, near the end of the tail. The fin rays seem to have been short and delicate."

In the "Preliminary Essay" of the "Tenth Decade" I described and gave a woodcut of the skull, represented in Plate I., fig. 2, of the present decade; and in a note at the end of that

Essay, I briefly adverted to the addition made to our knowledge of the genus by the specimen received from Dr. Taylor of Elgin, which I now proceed to describe at length.

#### GLYPTOPOMUS MINOR. (Pl. I., fig. 1.)

This is a cast, in tolerably fine-grained sandstone, of an entire specimen of *Glyptopomus*, the parts of which have undergone very little derangement. The sandstone block in which the fish has been preserved is split into two slabs, along a plane traversing the body of the fish, and, in general, midway between its dorsal and ventral surfaces. The one slab (fig. 1, Pl. I.) therefore, contains, for the most part, the impression of the dorsal surface of the fish, while the other exhibits the impression of its ventral surface; but the plane of splitting has not traversed the head, so that the impression of the jugular plates and lower jaw is left on both slabs. On the one, or dorsal slab, however, it is the impress of the inner surface of the bone of these parts which is shown, while, on the other, the outer or sculptured surface has left its mark.

The total length of the body of this fish is  $13\frac{3}{4}$  inches; it attains its greatest width ( $2\frac{3}{4}$  inches) in the middle of its length. Some allowance must be made, however, for the compression to which the fish has been subjected.

The greatest length of the head, measured in the middle line, from the anterior end of the snout to the level of the posterior margins of the opercular apparatus, is  $2\frac{3}{4}$  inches, or about one-fifth the length of the body.

The principal jugular plates (*G*) are each 2 inches long by about three-quarters of an inch wide at widest. The impression of their surfaces shows that they had had a finely-ridged, more or less granular, sculpture. There is no median jugular plate, and there is no positive evidence of the existence of any lateral jugular plates.

Behind, and partially overlapped by, the two principal jugular plates there is evidence of two triangular sculptured plates belonging to the pectoral arch; and behind these commence the series of ventral scales, which are irregularly four-sided, about a quarter of an inch wide by one-sixth of an inch long, and are disposed in transverse rows, which converge obliquely from above and without, downwards and inwards, to the middle line. The surface of the cast of each scale exhibits a multitude of minute hemispherical elevations, corresponding with the pits which constitute the well-known ornamentation of the scales of this genus.

The median dorsal scales are irregularly hexagonal, and the rows of lateral dorsal scales run from them as a centre, downwards and backwards, on each side, to pass into the lateral ventral series. The most anterior and largest of these median scales are as much as four-tenths of an inch wide by a quarter of an inch in length.



*Fig. 1.*

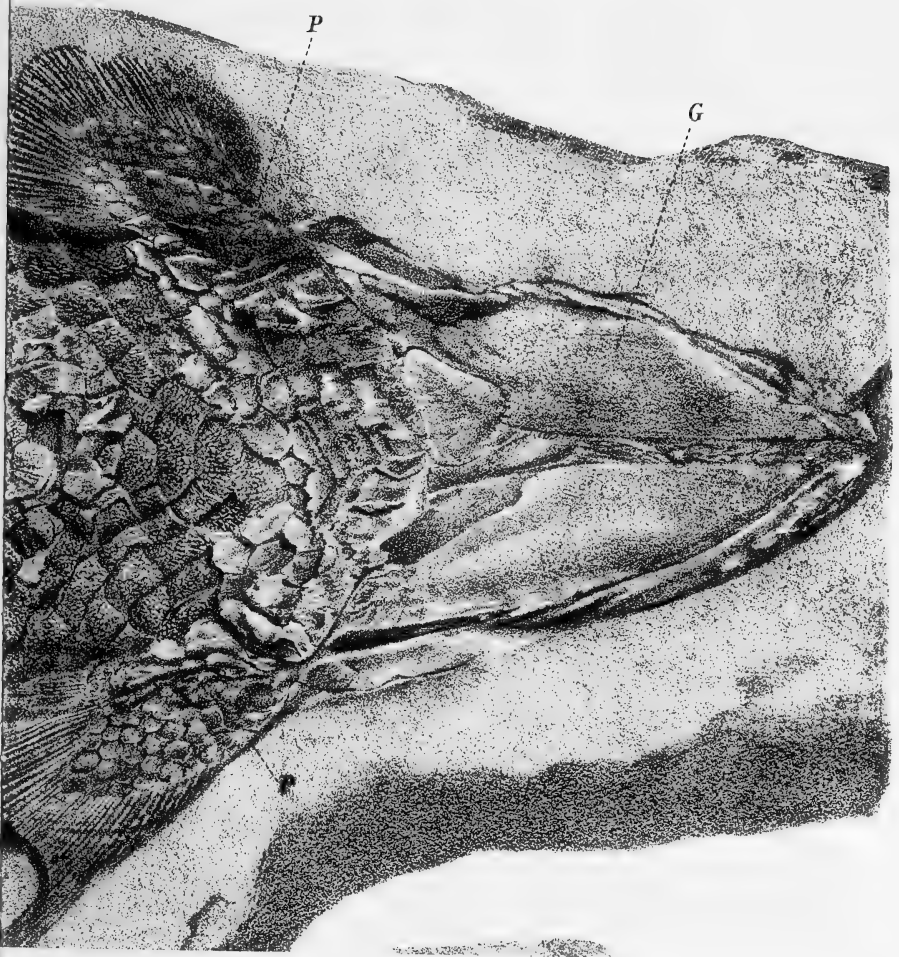




Fig. 1.

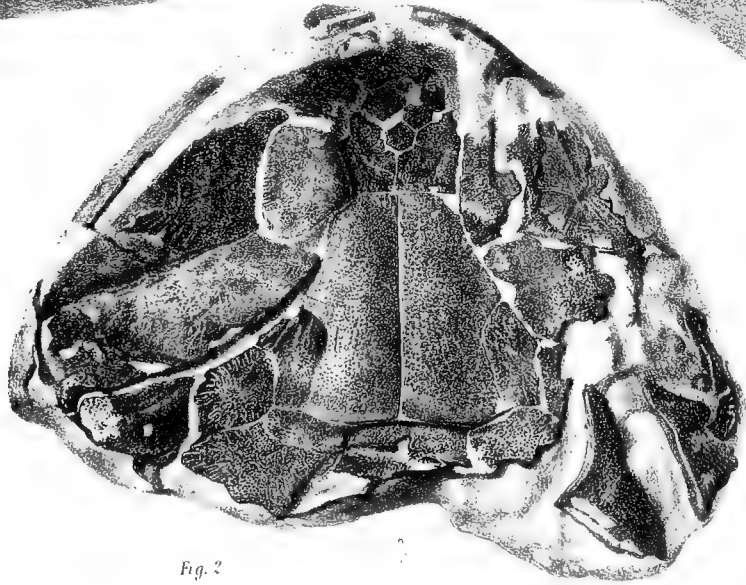
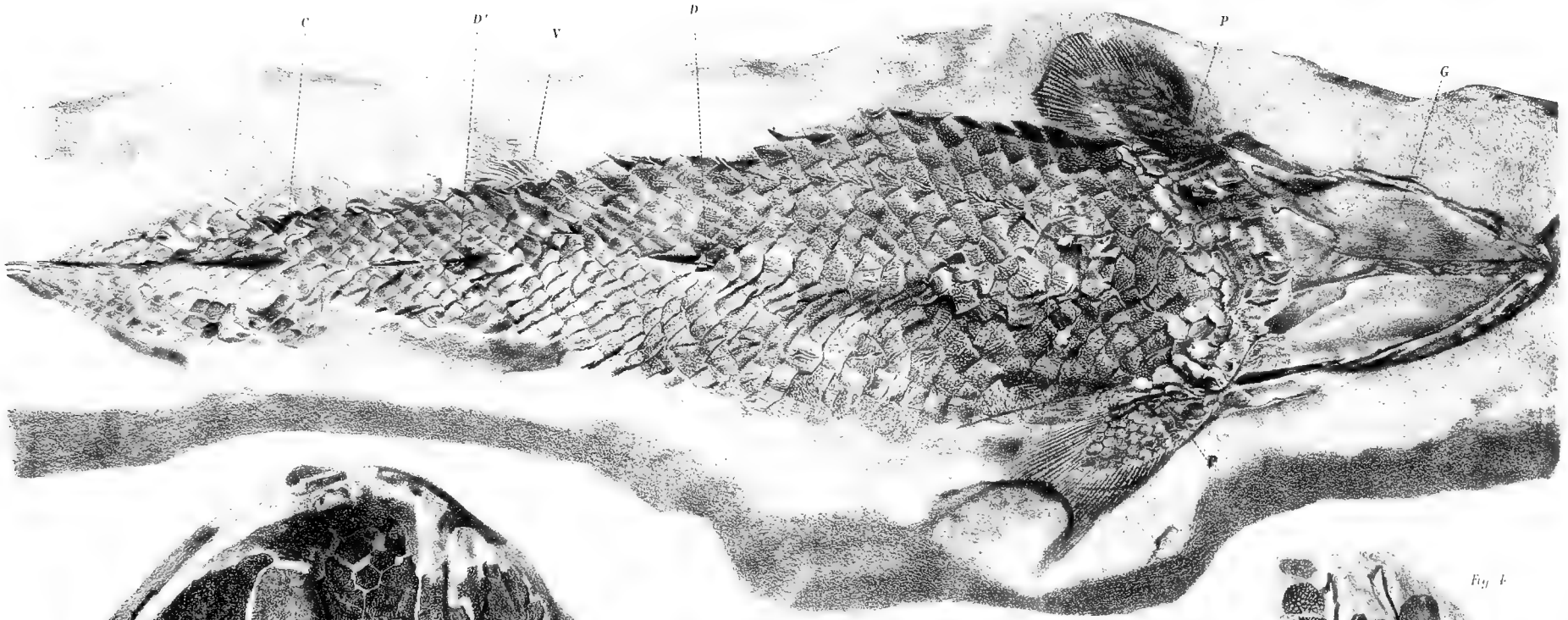


Fig. 2

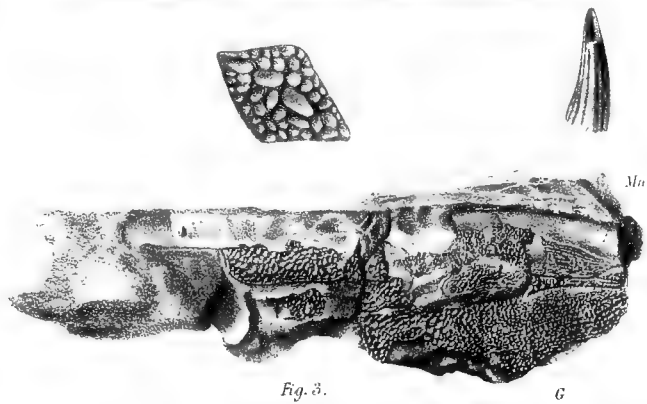


Fig. 3.



Fig. 4



The general character of the sculpture is the same on the dorsal as on the ventral scales. On the right side of the body some few of the scales in the position of the lateral line exhibit a grooved character, which is somewhat more prominent in the figure than it appears to my eye to be in nature.

The impression of the anterior dorsal fin (*D*) commences at seven inches and three-tenths from the anterior extremity of the muzzle; that of the second dorsal (*D*<sup>1</sup>) at about nine inches and a half from the same point.

The fin rays of the ventrals (*V*) are visible on one side in the dorsal impression (fig. 1), and, on both sides, in the ventral cast, just in front of the second dorsal. They seem to have been broad, but far shorter than the pectorals, and the impressions are so indistinct that I cannot say whether they are lobate or not.

The pectoral fins (*P, P*) are exquisitely displayed; each has a broad scaly lobe, subacute at the extremity, and more than an inch long, by half an inch wide. The scales exhibit the same sculpture as those on the body, but are much smaller, and diminish in size towards the apex of the lobe. The many-jointed fin rays are attached all round the margins of the lobe, and become longer towards its apex, where they form fully half of the length of the fin.

I see no trace of the anal fin in either slab. The impression of the well-defined upper lobe of the caudal (*C*) commences at eleven inches and a quarter from the anterior extremity of the muzzle. The lower lobe is not well shown in either slab; but I suspect from the size of the upper, that the tail is diphycercal.

The only tooth of *Glyptopomus* I have seen, fig. 4, is stout, conical, slightly curved, and deeply grooved longitudinally.

The jugular plates and the mandibles have a coarsely pitted and ridged sculpture (Pl. I., fig. 3).

These facts leave no doubt as to the position of *Glyptopomus* in the Glyptodipterine family of the suborder *Crossopterygida* among the *Ganoidei*.

#### DESCRIPTION OF PLATE I.

- Fig. 1. The cast of a specimen of *Glyptopomus minor*. In Dr. Taylor's Collection. *Nat. size.*
- Fig. 2. The skull of a larger *Glyptopomus* viewed from above. It is described in Decade X. "Introductory Essay," p. 4. In the British Museum. *Two-thirds of the size of nature.*
- Fig. 3. A fragment showing the sculpture of the jugular plates (*G*) and the mandible (*M*<sub>n</sub>). In the Museum of Practical Geology. *Nat. size.*
- Fig. 6. A slab with well preserved scales and a tooth of *Glyptopomus*. *Nat. size.* The tooth and one of the scales are represented separately and magnified.

## II.—ILLUSTRATIONS OF THE STRUCTURE OF THE CÆLACANTHINI.

### 1. *The genera CÆLACANTHUS and UNDINA.*

In the "Preliminary Essay upon the Systematic Arrangement of the Fishes of the Devonian Epoch," prefixed to the tenth decade of the "Figures and Descriptions illustrating British Organic Remains" (1861), I have endeavoured to prove that the genera *Cælacanthus*, *Undina*, and *Macropoma* constitute a very distinct family of the Crossopterygian Ganoids, to which the term *Cælacanthini* ought to be restricted.

At the time of the publication of this essay I was unaware that, in 1858, the late eminent paleontologist, M. Thiollière, had enunciated the same conclusion in the following terms:—

"La famille des Cælacanthes comprendrait à la fois, suivant son auteur, les *Sudis* de la faune actuelle, le *Glyptolepis leptopterus* du vieux grès rouge, et le *Cælacanthus granulatus* du terrain permien. Ce sont pourtant là trois types ichthyologiques beaucoup trop différents pour être ainsi réunis. Mais, si l'on exclut les deux premiers et qu'on associe au genre *Cælacanthus* lui-même les *Macropoma* de la craie et les *Undina* du Jura, on obtiendra le noyau d'une famille réellement naturelle, et que, pour éviter la confusion, M. Thiollière désignera par le nom d'*Ortho-cælacanthes*."\*

It is to be regretted that only the abstract of this paper has been published, as it would have been very interesting to learn the grounds upon which M. Thiollière's conclusion is based, and which are not stated in the "Note" whence the foregoing passage is extracted.

My own view of the common characters of these genera is given in the following definition of the suborder *Crossopterygida* and family *Cælacanthini* ("Preliminary Essay," p. 26).

#### *Suborder* CROSSOPTERYGIDÆ.

Dorsal fins two, or if single multifid or very long; the pectoral and, usually, the ventral fins lobate; no branchiostegal rays; but two principal, with sometimes lateral and median, jugular plates situated between the rami of the mandible; caudal fin diphycercal or heterocercal; scales cycloid or rhomboid, smooth or sculptured.

#### *Fam.* CÆLACANTHINI.

Dorsal fins two, each supported by a single interspinous bone; paired fins obtusely lobate; air-bladder ossified.

Since 1861 I have studied a considerable number of specimens

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\* *Note sur les poissons fossiles du Bugey, et sur l'application de la Méthode de Cuvier à leur classement*; par M. Thiollière. Printed in abstract in the "Bulletin de la Société Géologique de France," Se. 2, I. xv., pp. 782-793, 1858.

of Cœlacanthines belonging to the genera *Cœlacanthus* and *Macropoma*, without finding any reason to modify the definitions just given; but the materials which have passed through my hands enable me to illustrate the structure of these genera more fully than has hitherto been possible.

I commence these illustrations with the genus *Cœlacanthus*, for the opportunity of examining numerous specimens of which I am indebted to the Earl of Enniskillen, Sir Philip Grey Egerton, Bart., Dr. Rankine, of Carluke, Edward Binney, Esq., F.R.S, of Manchester, Dr. Garner, and Messrs. Molyneux, Ward, and Weston.

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### The Genus CÆLACANTHUS, Agassiz.

The name *Cœlacanthus* was first applied to a genus of fossil fishes by Agassiz, in the feuilleton of his "Recherches sur les Poissons fossiles," dated March 1836\*; and figures of the fragments from the Magnesian Limestone of Durham, to which he applied the title of *Cœlacanthus granulatus*, were published in 1839, in Plate 62 of the second volume of that work.

Furthermore, in the systematic catalogue of the fossil fishes in the collections of Lord Enniskillen and Sir Philip Egerton, the family *Cœlacanthes* had been established for the genera *Cœlacanthus*, *Holoptychius*, and *Macropoma*, with two additional species of *Cœlacanthus*, *C. lepturus* and *C. gracilis*, from the Carboniferous formation.

But no description of these specimens, or diagnoses of the genera, had appeared in 1842, when Count Münster published the fifth part of his "Beiträge zur Petrefacten-Kunde," containing figures and descriptions of the fishes from the Lithographic slates which he names *Cœlacanthus striolaris* and *C. Köhleri*.

Count Münster, however, had already published notices of these fishes in Bronn's "Jahrbuch," for 1842, and had applied the generic title of *Undina* to them. And he remarks, that if Agassiz' genus *Cœlacanthus* from the older formations is provided, like *Macropoma*, with conical teeth, the otherwise very similar fishes from the Lithographic slates would belong to a different genus, for which the title of *Undina* might be retained.

With this proviso Münster continues his description, as follows:—

#### "Genus CÆLACANTHUS, Agassiz.†

"Teeth flat, strongly granulated: scales thin, elongated, rounded off: two dorsal fins: caudal fin very large and broad, vertebral column traversing the middle of it, and forming at its point a second small pencil-like fin. Skeleton, with the exception of the vertebral column, bony; body elongated.

##### "1. *Cœlacanthus striolaris* . . . . .

I am acquainted with four specimens of this species, all of which were found at Kelheim, on the right bank of the Danube. The largest of them in my collection, measures a foot (Rhenish) from the head to the tip of the tail, and three inches five lines in breadth, without the fins; the smallest specimen, in which the apex of the head is wanting, is nine inches long and two inches six lines broad. The former is depicted in the second plate, but, since the thoracic and abdominal fins are not well preserved in the original, I have supplied these parts in the figure from other specimens. Both specimens, as well as a third, which I have had the opportunity of examining, lie upon one side, and exhibit a slightly convex back and an almost straight ventral line. The head is small, the forehead strongly arched; the bones of the head, however, are very brittle, and hence are badly preserved. Of the teeth only a few, as well

\* See Count Münster's "Beitrag" Heft, V. 1842.

† The references to the figures are, for the most part, omitted in this translation.



in the upper as in the lower jaw, are visible, and are seen, above, from the side, below, from the upper surface. Whether more than one series exists is not clearly discernible. The most distinct are a few teeth of the lower jaw, which are represented magnified in figure 8, have an angular flat form, and are strongly granular upon their upper surface; within these teeth a few others which were more rounded off appear to have been implanted in the lower jaw. The bone of the jaw, however, is so brittle that no more exact determination of this point can be made.

"The scales are relatively large, but so thin and so closely united together, that in a few spots, especially towards and amidst the caudal fin, they appear like a finely-striated membrane. . . . .

"They all exhibit fine, short, elevated ridges, and only the cervical scales are somewhat granular at their external ends. But the peculiar fins most especially characterize this fish.

"The first of the two dorsal fins, which lies over the pectoral fin, has eight simple rays, which, in their proximal halves, are deeply grooved, thick, and crenulated on the outer edge; on the upper side, towards the point, however, they are flat and closely jointed. The second dorsal fin has 13 or 14 flat, closely-jointed, rays, somewhat depressed in their middle part and grooved towards the root. This fin is placed directly over the anal fin, which has a perfectly similar size and composition. Fig. 14 depicts one of the median rays. The ventral fin is small, but indistinct and weathered. The pectoral fin has 13 or 14 flat closely-articulated rays, just like the two dorsal and the ventral fins. Most remarkable, however, is the broad caudal fin, which is divided by the unossified vertebral column into two halves, the upper of which bears 20-21 rays, the lower 18-19, which form prolongations of the vertebral processes. The outer side of the deeply-grooved rays is very finely notched, almost toothed; the thick spinal column forms, at the end of the two caudal fins, a pointed pencil-like second caudal fin, with 20 or 30 short flat closely-jointed rays. The unossified spinal column is finely striated; in the middle of it very short bones in pairs appear. The spinous processes are continued along the whole dorsum of the spinal column. Neither ribs nor special bodies of vertebræ are visible. In these specimens the stomach of the fish is rendered obvious by a depression, with a smooth shell-like investment, like what may be seen in most specimens of *Macropoma Mantelli*.

"2. *Cœlacanthus Kohleri*. . . . .

"I know of only one imperfect specimen of this species, for which I am indebted to the kindness of M. Köhler. The greater part of the head, with the pectoral and ventral fin of this individual, are wanting. It was at least one-third larger than the largest specimen of the preceding species, from which it is especially distinguished by its scales, which are covered with raised elongated points, almost like flies' eggs. The few scales whose external form is recognizable, resemble those of the preceding species, but are larger, and have elongated granulations upon their surface.

"The fins closely resemble those of the foregoing species. The first dorsal has nine thick rays, which are very long, and are distinguished from those of the preceding species by the rows of small spines which beset their outer sides as far as the middle. . . . . The point is flat and closely articulated.

"The second dorsal has 19 or 20 very broad, sharp-pointed rays, which are so close together that they come into contact in the middle.

“The anal fin is constructed like the preceding.

“The broad caudal fin is distinguished from that of the preceding species by a greater number of rays, and especially by many series of small spines on the outer side of the rays, as fig. 17 shows. In this species also the stomach with its smooth coat is visible.”

Another species of *Cœlacanthus*, from the Kupferschiefer of Richelsdorf, is described by Count Münster, at p. 49 of the same part of his “Beiträge,” under the name of *Cœlacanthus Hassia*. Though only a damaged skeleton without scales, it agrees closely, in general form as well as in its essential details, with *Cœlacanthus striolaris*.

The teeth are not recognizable. A few large scales lie scattered about. They are very large, but so thin that their proper form is not clearly distinguishable. However, they are all rounded off, smooth, raised from the exterior towards the middle, and correspondingly depressed below.

The anterior dorsal fin possesses ten very long, strong, simple rays, which are somewhat crenulated on the outer side, and jointed towards their end. The second dorsal fin has much finer articulated rays. The great ventral fin has long laterally crenulated rays; the vertebral column is unossified; the spinous processes of the vertebræ are only to be seen distinctly on the dorsal side of the vertebral column, and increase in size towards the tail.

It is clear from these descriptions that Count Münster was the first to indicate and define most of the great features of the organization of the Cœlacanthines, viz., the unossified vertebral column; the absent ribs; the shelly-walled internal organ, “like that of *Macropoma*”; the well-ossified head; the two dorsal fins; and the remarkable tail, with the singular characters of the fin rays.

Professor Agassiz first published his views respecting the Cœlacanth in 1843, when the second part of the second volume of the “Recherches sur les Poissons Fossiles” appeared.

In treating of the “Family of the Cœlacanth,” he writes, at p. 168 of this work, as follows:

#### “THE FAMILY OF THE CŒLACANTHS.

“I unite in this family many genera of an altogether peculiar physiognomy, but with whose true affinities I am, as yet, only very imperfectly acquainted. A remarkable peculiarity which has struck me in most of these fish, is the circumstance that their bones, and notably their fin rays, are all hollow internally, a peculiarity which is not met with in other ganoids, and which is the origin of the name “Cœlacanth” which has been conferred on the family. This character is especially striking in the true genus *Cœlacanthus*. To this singular structure of the bones is added another more apparent and more external character, viz., the form and disposition of the fins, and the mode of articulation of the rays; and, in the first place, most of the rays are stiff, or only articulated at their ends. Their combination with the apophyses [neural arches and spines] and inter-apophysial [inter-spinous] bones, is very singular,

especially in the caudal fin, the rays of which are supported by interspinous bones ; an arrangement which, in other fishes, is found ordinarily only in the anal and the dorsal [*caudale* in the text]. Lastly, the vertebral column is prolonged, more or less distinctly, between the principal lobes of the caudal fin, so as to form a median taper process."

Professor Agassiz then adverts to the resemblances and differences between *Cœlacanthus* and *Macropoma*, in a passage which I shall cite hereafter, and proceeds :

"Taking into account the extraordinary development of the dentary system in some genera of this family, and particularly in *Holoptychius*, one is tempted to approximate the Cœlacanthus to the Sauroids ; whilst the dentition of the genus *Undina*, as it has been described by Prof. Münster, would seem to establish a closer affinity with the Pycnodonts. On the other hand, the scales exhibit peculiarities which are to be met with in no other family, whence I have been disposed to arrange the Cœlacanthus provisionally between the Sauroids and the Pycnodonts. It may be, however, that their true place is near the Scleroderms, or the *Accipenseridae*."

Of the genus *Cœlacanthus* itself, Professor Agassiz remarks (p. 170):

"This genus, which I regard as the type of the family, was long known to me only by fragments ; but these were so different from most other ichthyolites, that I did not hesitate to form them into a distinct genus. What especially struck me was the form and the structure of the fins, their relation with the interspinous bones, and the manner in which the apophyses [vertebral arches and spines] are united on the one hand with the bodies of the vertebræ, and on the other with the interapophysial [interspinous] bones. The apophyses divide at their bases into two branches, forming a fork, which embraces the body of the vertebra ; to this apophysis succeeds an ossicle, which, instead of being interposed between two apophyses, is fitted on to the end of one, so as to form its direct prolongation. The ray properly so called, the longest of the three pieces, is also forked at its base ; its extremity alone is jointed, but never bifurcated. These three pieces, the apophysis, the inter-apophysial bone, and the ray, are about equal in length, and are all three hollow. . . . . This singular structure characterises most of the rays which lie at the posterior part of the body ; now as, usually, only the anal and the dorsal have inter-apophysial bones, I at first concluded that these two fins must be excessively developed ; and what helped to strengthen me in this idea, was the fact that the vertebral column appeared to be continued beyond the two azgyos fins, to form, further on, a bundle of very small articulated rays, attached directly to the vertebræ. But Lord Enniskillen's discovery of an entire specimen of this remarkable type has completely modified my views. It now appears that besides the fins of so exceptional a structure, which I regarded as anal and dorsal, this fish has a very distinct normal anal and two dorsals. Now, unless the existence of three dorsal and two anal fins of very different structure—an arrangement which occurs in no known genus of fishes—be admitted, it is necessary to regard the terminal fin of the body as a caudal. For the rest, this is not the only known example of a caudal supported by inter-apophysial bones, the caudal of *Polypterus bichir* being supported by similar bones, at least its upper lobe. What is truly exceptional is the prolongation of the tail beyond these rays, and the little fascicle of articulated rays surrounding its extremity. In this

respect my genus *Cœlacanthus* very nearly approaches the type of a fish from the Lithographic limestone of Kehlheim, for which Count Münster has proposed the generic name of *Undina*. But notwithstanding this analogy, and the altogether similar disposition of the other fins, the fish in question is distinguished by many peculiarities which do not permit it to be confounded with *Cœlacanthus*. The most important difference is presented by the dentition. The genus *Undina* has, according to Münster, pavement-like teeth, very similar to those of certain Pycnodonts. *Cœlacanthus*, on the other hand, has conical teeth, like the Sauroids, and everything leads to the belief that it is a carnivorous fish, so that, far from belonging to the same genus, it is doubtful whether it belongs to the same family. Leaving the caudal aside, the other fins of the genus *Cœlacanthus* present a very simple structure, composed of slender but not dichotomous rays. The first dorsal corresponds to the extremity of the pectorals. The second is opposite the space between the ventrals and the anal. The anal itself is very closely approximated to the caudal. This last fin (comprising in it the bundle of articulated rays which fringes the extremity of the vertebral column) nearly equals one-third of the total length of the fish. The vertebræ are much higher than they are long towards the anterior part of the trunk, but they become sensibly elongated posteriorly. It is the same with the apophyses, which, very slender in the abdominal region, take on a much greater development in the caudal region. The scales, to judge by the fragment of *C. granulatus*, are large, elongated, and have their posterior edge rounded. I have not been able to ascertain whether they are enamelled or not, but the fact that they are found in strata older than the Jura leads me to suppose that, as in all the fishes of that age, they were enamelled. Their extreme thinness, no doubt, has made them too fragile to be often preserved. I conclude from this description that the genus *Cœlacanthus*, although near the genus *Undina* of Count Münster, is nevertheless different from it, and that the latter should therefore form a separate type in the Cœlacanth family. Consequently it will be necessary to exclude from *Cœlacanthus*, and to place in *Undina*, the remarkable species which Count Münster has described and figured in the fifth part of his "Beiträge," under the names of *Cœlacanthus striolaris* and *Köhleri*. The true genus *Cœlacanthus* is at present restricted to the coal, the Zechstein and the Muschelkalk. I am acquainted with six species.

" *Cœlacanthus granulatus*, Agass. (Vol. 2, Tab. 62).

" The species to which I give this name was for a long time the only one known, and the two fragments which are figured were the only representatives of this remarkable family. Both represent the posterior part of a fish of very large size, which, to judge by the relative position of its fins, ought to have been at least two feet long . . . . . As a general rule the apophyses (neural spines and arches) and the inter-apophysial bones are equal in length. The rays, on the other hand, are a little longer, but they are never jointed down to their bases. The cleft of the ray into which the point of the inter-apophysial bone is inserted is much narrower than that of the apophysis (neural arch), which embraces the vertebral column. It is probable, from all I have been able to see, that, in reality, these anomalous rays are composed of filaments [*filets*], as in most other fishes, only these filaments do not become separate. The rays at the extremity of the caudal fin are exceptions to the general rule, inasmuch as they are directly attached to the vertebral column, without being borne either by an apophysis, or

an inter-apophysial bone. They are articulated, and appeared to be divided at their apices. It is these little rays which I considered, at first, to belong to the true caudal fin. I have explained above, in speaking of the genus, the reasons which have led me to withdraw this opinion, when I had the good fortune to discover a complete specimen of the type in the collection of Lord Enniskillen. Thanks to this discovery, I have been able to investigate the form of the vertebræ, which I found very massive, like the rest of the vertebral column. It has also led me to consider as a caudal fin all that great fin, borne by interapophysial bones, above and below the extremity of the tail; and, as an anal, the simple fin which precedes them below. The anal is composed of much more delicate rays, which, however, equally possess the peculiarity of being bifurcated and articulated only at their ends. The anterior ones are completely undivided.

“The granular spots observable here and there on our specimens are remains of the integument. I have seen fragments of scales only in a portion of another species of Cœlacanth, and from their structure I do not doubt that our *Cœlacanthus granulatus* was covered with similar scales. They are very delicate, and the concentric rings are very readily distinguished in them. The raised granulations which ornament their surface have originated the name *C. granulatus*, which I have given to this species.

“It was found in the Magnesian limestone of East Hickley, and the originals of the plate are in M. Witham’s collection.

“The species the description of which I reserve for the future, are—

“1°. *Cœlacanthus Phillipsii*, Agass. The caudal is more rounded than in *C. granulatus*, its rays are more close set and jointed nearer to their (proximal) ends. The apophyses of the caudal vertebræ are very long and delicate. The scales are large, and rounded posteriorly. From the Carboniferous rocks of Halifax.

“2°. *Cœlacanthus minor*, Agass. A very small species, remarkable for its very short inter-apophysial bones. The joints of the rays, properly so called, are longer than wide. The whole caudal is scarcely more than an inch long. From the Muschelkalk of Luneville.

“3°. *Cœlacanthus gracilis*, Agass. A species of unknown origin, distinguished by its elongated form; the pedicle of the tail, in particular, tapers evenly [*est tout d’une venue*], and its rays are less close set than in the other species.

“4°. *Cœlacanthus lepturus*, Agass. From the coal of Leeds. This species is still smaller than *C. minor*; its scales have rugose surfaces.

“5°. *Cœlacanthus Münsteri*, Agass. A beautiful species from the coal of Lebach, discovered by Lord Enniskillen, and characterized by its heavy form. It is in this species that I first saw the conical and hooked teeth of the genus *Cœlacanthus*.”

The ascription of ossified vertebræ to *Cœlacanthus* is certainly erroneous, and in the “Preliminary Essay” (l. c. p. 16), I have already given the reasons which lead me to demur to Professor Agassiz’s views regarding the systematic position and affinities of the Cœlacanths. Furthermore I have shown that “*Cœlacanthus Münsteri* is not a *Cœlacanthus*; and, consequently, that so far as the arguments in favour of an essential difference between the dentition of *Undina* and *Cœlacanthus* are based upon the dentition of that fish, they are untenable.

In Professor King’s “Monograph of the Permian Fossils,”

(1850), Sir Philip Egerton describes and figures a specimen of *Cœlacanthus granulatus* in his own collection.

“It shows little more of the fish than the figures given by Agassiz; but the scales are in a better state of preservation; they are irregularly rounded, and marked by fine undulating concentric lines. The enamel is thickly covered with the granulations which suggested the specific name. The second dorsal fin is also shown; it seems to have been larger and the rays thicker than in the anal fin opposed to it. The extremity of the tail is dislocated, and is seen in the lower part of the plate,” p. 235.

The next page of the work cited contains the description of—

“*Cœlacanthus caudalis*.

“There is a charming little specimen, in the possession of Lord Enniskillen, of a *Cœlacanth*, which I am inclined to think can scarcely be referred to the preceding species. The entire length does not equal that of the tail of the smallest specimen of *Cœlacanthus granulatus* I have seen. The latter species is supposed by Agassiz to have been two feet in length; this fish measures only five inches. The head is rather more than a fifth of the total length; the second fifth includes the first dorsal, the third fifth extends to the back of the second dorsal, and from thence to the end of tail, occupies the two remaining fifths. This large proportion of the caudal region inclines me to adopt the specific name given above. The body is slender and of uniform size. The first dorsal fin is composed of about eight strong rays; these are carried upon thick inter-apophyses; and the corresponding neurapophyseal elements of the vertebræ are enlarged to support them. The same arrangement is seen in the second dorsal, but the fin rays are more slender and more numerous. The pectoral, ventral, and anal fins are of moderate dimensions and slender structure. The tail is broader, and terminates more abruptly, than that organ in *Cœlacanthus granulatus*.”

The only other descriptions of *Cœlacanthus* (other than *Macropoma*) of which I have any knowledge, are contained in the following brief notes upon Carboniferous fishes of the United States, entitled “Description of several new genera and species of Fossil Fish from the Carboniferous Strata of Ohio,” by Dr. Newberry, contained in the “Proceedings of the Academy of Natural Sciences of Philadelphia,” vol. viii. p. 98, 1854.

“*CÆLACANTHUS*, Agass.”

“1. *C. ROBUSTUS*, Newb. Body robust, 1 foot 6 inches in length; upper surface of cranium covered with small closely-approximated tubercles, maxillaries and opercula threaded with fine parallel, sometimes interrupted, lines. Margin of opercula in mature specimens wavy.

“Scales elliptical, thin, 7 to 9 lines in length, nearly half the surface exposed; exposed portion covered with thread-like lines, similar to those of the opercula and maxillaries, and which converge towards the posterior angle of the scale.

“*C. ORNATUS*, Newb. Body, fusiform, slender, scarcely wider

than the head; size small, not exceeding 4 to 5 inches in length; upper surface of head ornamented with tubercles, which are much larger and more remote than in preceding species; opercula and maxillaries threaded, and like the scales, having stronger markings than in the larger species.

“Radial formula, A.D. 8; P.D. 5; C. 24?; A. 6; V.?; P.?”

“*C. ELEGANS*, Newb. Body fusiform, robust, 6 to 8 inches in length; cranial surface covered with closely-approximated tubercles; surface of opercular and maxillary bones threaded. All the ornamenting of the head relatively stronger than in *C. robustus*, but less so than in *C. ornatus*. Scales similar in form and markings to those of both these species, but more delicate than either. Anterior dorsal fin slightly in advance of ventrals; posterior dorsal as much forward of anal fin.

“Radial formula, A.D. 7?; P.D. 5; C. 22; A. 6; V. 9?”

In the course of the preceding history of the gradual discrimination of the forms which constitute the genera *Cælacanthus* and *Undina*, the following species have been mentioned:—

| Genus.             | Species.                         | Formation.     |
|--------------------|----------------------------------|----------------|
|                    |                                  | CARBONIFEROUS. |
| <i>Cælacanthus</i> | 1. <i>lepturus</i> , Agassiz.    |                |
|                    | 2. <i>Phillipsii</i> , Agassiz.  |                |
|                    | 3. <i>robustus</i> , Newberry.   |                |
|                    | 4. <i>ornatus</i> , Newberry.    |                |
|                    | 5. <i>elegans</i> , Newberry.    |                |
|                    |                                  | PERMIAN.       |
|                    | 6. <i>granulatus</i> , Agassiz.  |                |
|                    | 7. <i>Hassia</i> , Münster.      |                |
|                    | 8. <i>caudalis</i> , Egerton.    |                |
|                    | 9. <i>minor</i> , Agassiz.       | TRIASSIC.      |
|                    |                                  | OOLITIC.       |
| <i>Undina</i>      | 10. <i>striolaris</i> , Münster. |                |
|                    | 11. <i>Kohleri</i> , Münster.    |                |

Besides these there are *Cælacanthus gracilis*, Ag. of unknown locality and formation, and the so-called “*Cælacanthus*” Münsteri, which must be excluded from the genus *Cælacanthus*.

To the important question, how many of these nominal species are truly distinct, and what are their diagnostic characters, I must confess myself unable to give any satisfactory reply.

I have examined the specimens originally named *Cælacanthus lepturus* by Agassiz, in Lord Enniskillen’s collection, and I entertain no doubt that the specimens from the Staffordshire coal-field described in the present decade are specifically identical with these; but I can find no certain diagnosis by which this species is to be distinguished from the *C. elegans* of Newbery (though I by no means affirm the identity of the two), and I have not seen *C. Phillipsii*, *C. robustus*, and *C. ornatus*.



I have examined specimens of *C. Hassiæ* and *C. granulatus* in Lord Enniskillen's collection. They are undoubted Cœlacanth, a specimen of *C. Hassiæ* exhibiting the characteristic anterior dorsal interspinous bone, but no scales were preserved in any of the examples, nor were they in such a state as to allow of any useful comparison of the proportions of the body and fins.

*C. caudalis* is discussed below. Of *C. minor* I have seen no specimen, and Prof. Agassiz' diagnosis is insufficient to enable me to give any opinion concerning its specific distinctness.

Again, the differences between the genera *Cœlacanthus* and *Undina* appear to me to be anything but clearly made out. The close similarity of the two genera in the broad features of their structure is indubitable; and it is open to doubt whether the differences in the dentition are not more apparent than real.

Under these circumstances I shall adopt the generic and specific names, which have been used by my predecessors, provisionally, and without intending, for the present, to express any opinion as to their real value.

### I. *Cœlacanthus lepturus*, Agassiz.

#### No. 1. *The specimen represented in Pl. II., figs. 1, 2, 3, 4.*

This fossil fish is nearly entire, only a small portion of its caudal extremity being absent. Its total length could not have exceeded five inches.

The length of the head appears to have been about 1·3 in., but the snout is somewhat crushed, and the occipital boundary is but indistinctly indicated.

The depth of the body, at the level of the anterior edge of the anterior dorsal fin (*D*) is 0·95 in. The anterior dorsal fin itself is 0·75 in. distant from the occiput, and 0·2 in. broad at its base. Twelve stout fin rays can be counted in it, the anterior three being shorter than the others, and gradually increasing in length to the fourth, which is about 0·75 in. long. I can discern no ornamentation upon any of these fin rays, which appear to be quite smooth, and become divided into broad quadrate joints in their distal moieties.

The remains of a large interspinous bone are seen at the base of the dorsal fin rays, and supporting them.

The fin rays of the second dorsal have disappeared, but I believe I can perceive indications of its interspinous bone.

The caudal fin (*C*) is very imperfect; the anal and pectoral fins are absent; but the right ventral (*V*) is seen in place, a little behind the level of the anterior dorsal. It is a considerable fin, as large as the anterior dorsal itself.

The scales of this fish are thin, flat, cycloidal, and 0·15 to 0·2 in. in diameter. The middle of the posterior margin of many of the scales (figs. 3 and 4) is produced, so that the exposed portion is nearly triangular. The sculpture consists of raised, continuous, ridges, which converge towards the middle line.



The pectoral arches are strong and broad, and have somewhat spatulate upper ends; they exhibit no sculpture.

Some points in the structure of the skull are so well displayed in this specimen that I have given an enlarged view of it in fig. 2.

The posterior moiety of the roof of the skull (*A*) meets the anterior at an obtuse angle, and exhibits no trace of sutures. The outer surface of this, apparently single, bony shield is ornamented with minute oval tubercles of enamel, which, posteriorly, run together into short ridges. Very little of the anterior moiety of the roof of the skull is preserved, but so much as remains shows a similar ornamentation.

The right operculum (*Op.*) is broad and triangular; its surface is marked by ridges, which take a radiating course from its anterior superior angle. These ridges are rather more interrupted, and as it were tuberculated, than they are shown to be in the figure.

Between the dislocated operculum and the suspensorial apparatus for the lower jaw, several ossified branchial arches (*Br.*) are visible.

The suspensorium itself consists of a closely united hyomandibular (*H.M.*) and palatoquadrate (*P. Qu.*) portion. The latter is a triangular strong plate of bone, and its downwardly and backwardly directed apex ends in a stout condyle for articulation with the mandible. Its upper edge is sharp and free, and its anterior thinner angle becomes connected with the skull, but, in what manner, the state of the specimen does not enable me to say.

The hyomandibular portion of the suspensorium is, inferiorly, covered by the palatoquadrate, but above, it appears, to be stout and prismatic. External to the anterior two-thirds of the outer edge of the palatoquadrate, what appear to be the remains of a maxilla are visible.

Emerging from beneath the anterior attachment of the palatoquadrate, there is a small process of bone which enlarges at its free end (*d*). A similar process, apparently developed from the prefrontal, is seen in *Macropoma* and *Undina*. In front of this, obscure traces of one or two sharp pointed teeth are visible.

The impressions of the right ramus of the lower jaw, and of one of the displaced jugular plates (*G*) are to be seen below the head.

This instructive specimen (like the others, unless the contrary be stated,) was obtained from the Coal measures of Pendleton by Mr. Molyneux, and is now in the Museum of Practical Geology.

*No. 2. The specimen represented in Pl. III., figs. 1., 1a., 1b.*

This is a figure, magnified to twice the natural size, of a small *Cœlacanthus lepturus*, not more than three and a half inches long, and so disposed as to display the unusually perfect caudal extremity very well.

The skull is about 0·7 in. long; and, posteriorly, where it is much crushed, it has about half that width.

It is seen from below, and the interspace between the rami of the mandible (*a, a*) is occupied by the two broad and elongated

jugular plates (*G*). The surface of each of these bones exhibits a very peculiar ornamentation, consisting of delicate undulating ridges, which, on the whole, run more or less parallel with the outer edges of the jugular plate, but, in front, converge towards its inner edge. The peculiar form and sculpture of the rami of the mandible, are better displayed by other specimens. In front of their symphysis there is a confused mass, doubtless formed chiefly by the premaxillæ, and which exhibits indications of small teeth.

The broad ends of the pectoral arches are displayed at *b*; but the pectoral fins are not visible.

The large, obtusely lobate, ventral is well shown at *V*. It has, at present, fourteen fin rays, which gradually increase in length on either side towards the middle four, which are about equal. These rays present no sculpture, but the broad jointing of their distal halves is very well displayed.

The remains of the dorsal fin appear at *D*.

The caudal fin has about ten fin rays above and below, which are connected with the neural spines by interspinous bones. The rays are jointed in their distal moieties; and the hindermost ones are shorter than the others, and lie more nearly parallel with the axis of the body. The latter narrows rapidly from the commencement of the caudal fin, and continues scaly to its truncated and evidently broken extremity.

The scales *a*, fig. 1*a*, have the same form and sculpture as in the preceding specimen. Fig. 1*b*. exhibits a magnified view of the ornamentation of part of one of the jugular plates.

*No. 3. The specimen represented in Pl. III., fig. 2.*

The chief interest of this specimen (figured of twice the natural size) arises from its showing at *b* the crushed walls of the ossified air bladder, and, at *a*, what appears to be the interspinous bone of the posterior dorsal fin. Its crura diverge at a somewhat more open angle than that shown in the figure. The anterior dorsal fin (*D*) of this specimen is unusually long.

*No. 4. The specimen represented in Pl. III., figs. 3, 3a, and Pl. IV., figs. 1 and 2.*

Of these figures the first is of the natural size; the two others are magnified, and fig. 2, Plate IV., has been accidentally inverted. They are taken from the two counterparts of a split specimen, and throw much light upon the structure of the mandible, the jugular plates, and the branchial apparatus.

Each ramus of the mandible (*Mn*), when viewed laterally, as in fig. 2, Plate IV. (which represents the right ramus) presents a nearly straight lower margin, while the upper edge is sinuous; the upper contour of the ramus attaining its greatest height rather behind its centre, and thence rapidly descending forwards and backwards. In the horizontal plane, the hinder part of each ramus is nearly straight, but its anterior end curves sharply inwards towards that of its fellow (Plate IV., fig. 1), to the symphysis.

The outer surface has an ornamentation composed of minute ridges of enamel, the ridges having a direction generally parallel with the axis of the ramus.

In the elongated oval jugular plate (*G*) of this specimen (Plate IV., fig. 1.), the ridges of the ornamentation are more completely transverse to the axis of the plate than in the specimen No. 3 (Plate III., fig. 2).

The impressions of five strong bony branchial arches are plainly visible on the left side. Minute horny, or osseous, filaments seem to have been set at right angles to the branchial arches along their edges (Plate IV., fig. 1).

Connecting the branchial arches is a strong median ossification, consisting of an anterior cruciform part, and a posterior elongated spatulate portion. The two anterior branchial arches are connected, the one with the outer end, and the other with the base, of a transverse arm of the cross; the three other arches unite with the sides of the posterior division, while the long spatulate end lies free between the hindermost pair of arches (Plate IV., fig. 1). Fig 3a. represents a scale of this specimen magnified.

*No. 5. The specimen represented in Pl. IV., fig. 3.*

The under surface of a crushed head of *Cælacanthus lepturus*, showing the ornamentation of the jugular plates. In the collection of Edw. Binney, Esq. F.R.S.

*No. 6. The specimen represented in Pl. IV., figs. 4 and 5.*

These fragments, figured of the natural size, show, in fig. 4, the elongated pelvic bones still connected with a part of the ventral fins; and, in fig. 5, the anterior (*D*) and posterior (*D*<sup>1</sup>) dorsal fins, apparently but little displaced from their normal position.

*No. 8. The specimen represented in Pl. IV., fig. 6.*

A very perfect hinder moiety of a *Cælacanthus*, somewhat larger than any of the foregoing, drawn  $1\frac{1}{2}$  times the size of nature.

The persistent notochordal space, with the superior and inferior bony arches and spines, the interspinous bones, and the fin rays, are very clearly displayed. There seem to be 12, or perhaps 13, fin-rays in each lobe of the caudal fin; and, as in No. 2, the posterior fin-rays lie nearly parallel with the axis of the body. The jointing of the broad distal portion of these rays is very distinct. The scaly central part of the body (*C*<sup>1</sup>) passes backwards into a prolongation about 0.1 in. wide, also covered with small scales, and beset along its upper and lower margins with small fin-rays, which appear to be simple and unjointed.

*Cælacanthus lepturus* attained considerable dimensions. A specimen obtained by Mr. Molyneux from the Ladies Well Colliery,

Cheadle, North Staffordshire, shows that the parieto-occipital region of the head was at least 1·5 in. long, and that the length of the whole head could not have been less than  $3\frac{1}{4}$  inches. The entire fish, therefore, was probably not less than 12 to 14 inches in length.

In this large specimen the surface of the parieto-occipital region, and of so much of the frontal region of the skull as is preserved, as well as that of the opercula, are covered with oval tubercles of enamel, set so closely as to leave no interspace. On the parieto-occipital shield these tubercles are about  $\frac{1}{90}$  of an inch long, but on the opercula and the fragments of the external facial bones they become both actually and proportionally longer. The left pectoral fin is about an inch and a half long, and has a distinct, though small, scaly lobe. The ornamentation of the scales is quite as in the smaller specimens, but the scales are fully 0·3 in. in diameter.

## II. *Cœlacanthus elegans*, Newberry.

I am indebted to Sir Philip Egerton, Bart., for the opportunity of studying several specimens of the *Cœlacanthus elegans* of Dr. Newberry, from Liston, Ohio, and I figure three of them for comparison with *Cœlacanthus lepturus*.

### No 1. *The specimen represented in Pl. V., fig. 1.*

The caudal extremity of this specimen is broken off, but its extreme length, when entire, could hardly have exceeded 5·75 in. The length of the head is 1·3 in., so that the whole body was between four and five times as long as the head.

The fish is crushed in such a manner as to have its depth unnaturally increased, and the right ventral fin is seen to be detached, and lies below the left. From the line of the back at the front boundary of the first dorsal fin, to the opposite point of the belly is 1·4 in.

The scales, in a tolerably good state of preservation, are about 0·15 in. in diameter, thin and flat, and would be circular were not their posterior margins produced into an obtuse point (Plate V., fig. 3).

Each scale is ornamented with narrow, wavy, nearly parallel ridges, which converge towards and meet along, a line drawn through the centre and the point of the scale. I observe no marked differences among the scales of different parts of the body, nor any trace of a lateral line.

The neural arches have the ordinary form, and are close set. A series of subvertebral arches correspond with them in the caudal region, but there is no more trace of ribs in this species than in *C. lepturus*.

Fourteen or fifteen fin rays, jointed in their distal portions, are discernible in the anterior dorsal fin (*D*), and seven or eight in the posterior (*D*<sup>1</sup>), the anterior edge of which is opposite the most

anterior subvertebral bones. A large single interspinous bone supports the anterior dorsal fin, but the interspinous bone of the second dorsal is concealed.

The anal fin (*A*) is but obscurely indicated, but lies rather in front of the anterior margin of the second dorsal. The left ventral fin is in place, and is situated as in *C. lepturus*. The strong and broad bones of the pectoral arch are devoid of sculpture externally, and in form resemble those of *C. lepturus*.

The upper contours of the anterior and posterior regions of the skull do not pass evenly into one another, but meet at an obtuse angle. The operculum is large, extending from the roof of the skull to near the angle of the jaw, and has the form of a triangle with the base upwards. It is ornamented with fine ridges, which, on the whole, radiate from its anterior superior angle. The structure of the skull in front of the operculum cannot be deciphered.

The mandible is in place, though a good deal broken. So much of its outer surface as is preserved exhibits the characteristic sculpture.

Minute conical teeth are visible at the anterior end of the snout, and there is one in the palatine region, but these teeth are detached, and but obscurely visible.

*No. 2. The specimen represented in Pl. V., fig. 2.*

In this example the tail, with the anal (*A*) and second dorsal (*D*<sup>1</sup>) fins, are well displayed. Twelve fin rays, having the same arrangement as in *C. lepturus*, can be counted above and below, and there is a medial scaly caudal prolongation, which, however, is not sufficiently preserved to show the small fin rays which it doubtless possessed.

*No. 3. The specimen represented in Pl. V., fig. 4.*

A much crushed head, showing the jugular plates and scales of *Cœlacanthus elegans*, and exhibiting three, or perhaps four, sharply pointed conical teeth, connected to all appearance with the premaxilla. The largest of these teeth is not more than 0.05 in. long. The ornamentation of the jugular plates is like that in *C. lepturus*.

*III. Cœlacanthus caudalis, Egerton (Plate V., fig. 5).*

Sir Philip Egerton's excellent account of this species has already been quoted at length, and I describe and figure the type specimen anew, merely for the purpose of comparing it with the *Cœlacanthus* already described, and of using it to supplement the information derived from them.

In fact, although the head of this specimen is much crushed, the extreme end of the tail is absent, and the scales are wanting, the skeleton of the trunk and fins has left the mark of its parts in almost undisturbed relation to one another.

The animal is a little bent up towards the dorsal side. Its length, measured in a straight line, is 4.7 in.; the head is 1.1 in. long, or, as in *C. elegans*, rather more than one-fifth the whole body. The front edge of the anterior dorsal fin (*D*) is distant 1.85 in. from the end of the snout, and the base of this fin is 0.25 in. long. From the front edge of the first dorsal to that of the second (*D*<sup>1</sup>) is a distance of 0.95 in.; the base of the second is 0.2 in. long. The front edge of the upper lobe of the caudal fin (*C*) is 0.7 in. from the front edge of the second dorsal, and 3.6 in. from the end of the snout. Only the right pectoral fin, detached from the pectoral arch and thrown backward, is visible. The two ventrals (*V*) close together, and opposite the level of the posterior margin of the anterior dorsal, are apparently in, or close to, their natural position; they are distant 2.35 in. from the snout.

The small anal (*A*) is opposite the second dorsal, and 3.15 in. from the snout.

The greatest depth of the fish, 0.95 in., is opposite the first dorsal fin.

The pectoral fin (*P*) is rather more than 0.5 in. long, and 0.2 in. broad at its base; it is obtusely lobate, and contains, at fewest, 18 fin-rays. The foremost of these rays are unjointed through the greater part of their length.

The ventral fin (*V*) is 0.6 in. long and about 0.2 in. broad, or of nearly the same size as the pectoral. It is obtusely lobate, and 17 or 18 fin-rays may be counted in it. As in the pectoral fin, the foremost of these fin-rays are shorter than the others, and remain undivided through a great part of their length.

An impression of one, or both, of the pelvic bones (*Pv*) lies in front of the ventral fins, but apparently out of its normal position, as its base is in advance of these fins.

The anal fin (*A*) is somewhat bent upwards and backwards out of its natural position. What there is of it has a length of 0.4 in., a breadth at the base of 0.15 in. Fifteen or sixteen fin-rays may be counted, and they appear to be similar in structure to those of the pectoral and ventral fins. - There is no evidence that this fin was lobate.

The base of the inferior lobe of the caudal fin (*C*) is 0.75 in. long, and exhibits 14 fin-rays, the hindermost of which are nearly parallel with the axis of the body, and probably indicate the natural termination of the fin. The anterior are shorter than the posterior fin-rays, and, so far as they are preserved, none of the fin-rays exhibit distinct joints.

The upper lobe of the caudal fin resembles the lower, and begins opposite to, or perhaps a little in advance of it.

The interspinous bones appear to correspond in number to the fin-rays, (unless there may be one or two in front which have no fin-rays,) and to be broader at each end than in the middle. Opposite the anterior end of the caudal fin, the whole depth of the body is about 0.65 in., and is divided into five nearly equal areas by the impression of the notochord in the middle and those of the vertebral arches and interspinous bones, above and below.

The second dorsal fin ( $D^1$ ) contains 14 rays; its basal breadth is 0·2 in., its length not less than 0·5 in. The rays are slender, and only become jointed towards their extremities. The peculiar forked interspinous bone of this fin is not in its place, but I believe I can trace indications of it in the space between the lower edge of the first dorsal and the ends of the neural arches.

The first dorsal ( $D$ ) is fully 0·8 in. long and 0·25 in. broad at the base; 11 or 12 fin rays can be counted, which are much stronger than those of the other fins, and, like the others, are only jointed at their tapering distal ends. I observe no spine-like tubercles upon these, any more than upon the other, fin-rays. The impression of the broad interspinous bone of this fin is plainly visible *in situ*.

About 23 close-set superior, or neural, ossified arches, occupying about 0·5 in., may be counted immediately behind the head. The spinal column is there interrupted for nearly the same distance, and a solitary neural arch is seen thrown down out of the series. Behind this point the neural arches are undisturbed, and opposite them, on the ventral side of the body, the series of subvertebral arches commences. That the point at which these commence is, in fact, part of the caudal region is shown by its relation to the position of the ventral fins. More than 40 neural arches can be counted behind the break, and there were therefore probably not fewer than 80 in the whole series. The number of subvertebral arches cannot be satisfactorily ascertained. There are no ribs in the dorsal region.

I am inclined to think that a distorted and V-shaped elevation which occupies the portion of the cavity of the body immediately under the anterior dorsal fin, is the remains of the ossified air bladder.

The head is so crushed that nothing definite can be made of its structure. The strong pectoral arches are discernible immediately behind it, but they also are much crushed.

No sculpture is visible upon what remains of the cranial bones.

#### IV. *Cœlacanthus elongatus*, Huxley.

The specimens to which I have applied this name, rather because I cannot identify them with any other species than because they have good positive characters of their own, are all mere impressions in shale, from Ballyhedy, near Ballinhassig, county of Cork, Ireland. They were sent to me by my colleague, Professor Jukes, the local director of the Geological Survey of Ireland, and are now in the collection of that Survey.

##### No. 1. *The specimen represented in Pl. V., fig. 6.*

This fish was probably about 3·5 in. long when entire. The head is somewhat less than one inch long, and appears more elongated and tapering in proportion than in the other species.

The anterior edge of the dorsal fin is 0·65 in. from the head,

and is thus further back in proportion; the depth of the body at this point is 0·5 in.

The cranial impression is marked by deep and irregularly disposed lines, the correspondence of which with the probable outline of the cranial and facial bones is not apparent. Besides and between these markings the impression of the skull presents traces of a minutely granular, or lineated, sculpture.

The anterior dorsal fin (*D*) is 0·5 in. long, but only eight or nine of its fin rays are preserved, and there is no trace of the interspinous bone. There is an interval of 0·7 in. between the bases of the anterior and posterior dorsal fins, and the latter (*D*<sup>1</sup>) exhibits 13 or 14 long fin rays, with one or two short ones in front; the whole fin is 0·4 in. long.

The impressions of both bones of the pectoral arch are discernible, and the confused fin rays of apparently both pectoral fins (*P*). Each fin was about 1·5 in. long. About 37 neural arches may be counted, those nearest the head being smallest. There are no dorso-abdominal ribs, and the subventral bones begin nearly opposite the 25th neural arch. No ventral fins, nor any part of the caudal, are visible, in consequence of the breaking away of the matrix in their region.

*No. 2. The specimen represented in Pl. V., fig. 7.*

This is very like the preceding, but in some respects it is more complete. The extreme length is 3·6 in. The length of the head is about 0·85 in., unless the anterior end of the snout is absent. The head presents longitudinal and oblique groovings similar in their general character to those of the foregoing example: and, as in the latter, there is a rounded depression, like an orbit, situated at the junction of the posterior and the anterior three-fourths of the length of the head. Here and there, indications of a granular and lineated sculpture are visible. The impressions of the bones of the pectoral arch are well seen; they appear not to have been so rounded and expanded above as in the other *Cœlacanth*s.

Twenty-five dorsal abdominal neural arches, unaccompanied by ribs, can be counted (there were probably several more) before the series of subvertebral bones begin, on the under side of the space occupied by the notochord.

The front edge of the anterior dorsal fin (*D*) is 0·6 in. from the posterior end of the head. At least ten rays can be counted in it, but its distal end being hidden under matrix, its precise length cannot be ascertained. An interval of 0·6 in. separates the bases of the two dorsals, and so much of the second (*D*<sup>1</sup>) as is visible, shows it to have been, as in the preceding specimen, stouter than the first dorsal. Thirty-seven neural arches can be counted in front of the point of commencement of the upper lobe of the caudal fin (*C*), the impression of which shows it to have had the ordinary *Cœlacanth* structure. The anal and ventral fins are not visible. Both pectorals (*P*) are seen, the right nearly in place. Its rays are very delicate and nearly 0·7 in. long if traced to their extreme ends. No trace of the pelvic bones, or interspinous bones, is visible.



This Cœlacanth appears to have attained much larger dimensions, as a fragmentary specimen from the same locality has neural arches 0·45 in. long, whilst those of the example described nowhere reach 0·2 inches.

A fragment of a caudal extremity of a Cœlacanth, in the same collection, leads me to suspect that a second, deeper and shorter bodied, species may have coexisted with this.

Numerous specimens sent to me by Prof. Jukes demonstrate the existence of a true *Cœlacanthus* in the Coal measures of Ballybunnion, Kerry. The largest impressions belong to fish about 12 inches long, and the fossils vary from this size to less than six inches. In none are the scales or the form of the head preserved, and hence I can give no strong opinion as to the specific distinctness of this Cœlacanth, or its identity with other species. I am inclined to think, however, that it is rather more slender than *C. lepturus*.

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The Genus *HOLOPHAGUS*, Egerton.

The unique specimen upon which this genus is based is thus described by Sir Philip Egerton in a note at page 19 of the "Preliminary Essay" of the tenth Decade:—

*Holophagus Gulo.*

"Mr. Harrison's specimen wants the anterior portion from the dorsal and pectoral fins forwards. From the insertion of the dorsal fin to the extremity of the tail it measures  $11\frac{1}{2}$  inches, and  $4\frac{1}{2}$  inches in depth. The stomach is distended with a recently swallowed *Dapedius*, and a large coprolite occupies the rectum. The first dorsal fin springs (as in *Macropoma*) from a single disc, resulting from the coalescence of the interneural spines. It contains eight long, thick, undivided, and multi-articulate rays. They are beset with numerous short spines or tubercles. The second dorsal is situated 4 inches behind the first. Between the two is seen a strong bifurcate interneural ossicle, which has been displaced forwards from its proper position at the base of the fin. The second dorsal fin contains sixteen rays. The anterior ones are short and slender. The succeeding ones are long, broad, and multiarticulate, but not tuberculate. The base of the fin is obtusely lobate, with a scaly investment. The pectoral fins are much mutilated. Judging from what remains of them, and from some indistinct impressions, they seem to have been of great size. The anal fin occurs immediately below the second dorsal fin, with which it corresponds in form and structure, but contains many more rays. The ventral fins are mutilated, but their position below the first dorsal fin is indicated by the preservation of a pair of strong T-shaped pelvic bones, having their longer limbs directed forwards, and nearly reaching the base of the pectoral fins. The caudal fin is of great size, and presents in an eminent degree the most special and characteristic feature of the *Cœlacanthus* family, namely, the interposition, in the caudal region, of an interneural between the neural and dermoneural spines. The base of this spine abuts upon the extremity of the neural spine, and unites with the true fin ray by an overlap or splice. This structure coincides with that observed in *Undina*. In *Macropoma* the bone of the interneural spine is bifurcate for the reception of the distal extremity of the neurapophysis. A small supplemental fin extends an inch beyond the larger caudal fin, as in *Undina* and *Cœlacanthus*. The notochord is unossified. The apophyses, both above and below, have very wide bases. The scales are curvilinear, and covered with a vermiculate pattern on the upper surface, occasionally broken up into small tubercles."

The specimen referred to in the foregoing description is in the Museum of Practical Geology, and is figured, one-half the size of nature, in Plate VI.; with enlarged views of a scale, of anal and of caudal fin-rays. *D* is the first dorsal fin; *D*<sup>1</sup>, the second dorsal fin; *D*<sup>1</sup><sub>1</sub>, its interspinous bone; *A*, the anal fin; *C*, the caudal fin; *C*<sup>1</sup>, the supplemental caudal fin-rays; *Pv*, the pelvic bones.

The Genus *MACROPOMA*, Agassiz.I. *Macropoma Mantellii*, Agassiz (Plates VII. and VIII.)

Attention was first directed to this remarkable genus of Cœlacanth fishes, in 1822, by the late Dr. Mantell, who, at page 239 of his work "The Fossils of the South Downs," gives the following account of the specimens which had fallen under his observation:—

*Amia? Lewesiensis.* Tab. xxxvii., xxxviii.

"The length of this ichthyolite generally exceeds 18 inches, the head being equal to one-third of the whole; the width is about 4.5 inches. The body is of an elongated form, slightly compressed, scaly and reticulated.

The scales are of a rhomboidal shape, and beset with numerous small adpressed spines, producing a scabrous reticulated appearance, not unlike the surface of some kinds of *Balistes*. The head is angulated; the orbit large; the opercula smooth and rounded; the jaw dentated and nearly straight. The teeth in the upper maxilla are conical, pointed, and rather flat; there are about 40 on each side, of which the eight or nine anterior ones are the largest. Those of the lower jaw are exceedingly small and very numerous. The dorsal fins are two in number; the anterior one (*a*, Tab. xxxvii.) is placed in a sulcus or groove in the back, and appears to have been capable of erection or depression; it consists of eight strong rays, the two first being garnished with spines. The posterior dorsal fin (*b*, Tab. xxxvii.) is remote from the other, and composed of numerous delicate rays. The pectoral fins are placed on the thorax, near the lower margin of the opercula. The ventral fins (*c*, Tab. xxxvii.) are attached to the abdomen opposite to the anterior dorsal fin. The anal fin is unknown. The tail appears to have been rounded, but no perfect specimen of this part has been obtained. The tongue is occasionally preserved (*vide* Tab. xxix., fig. 6; Tab. xxxiv., fig. 7.) It is of a triangular form, and its surface is covered with numerous papillæ. The air bladder is of an elongated oval shape, and lies in the abdomen immediately beneath the spine."\*

Dr. Mantell compares the fish with *Mugil*, *Balistes* and the *Amia ignota* of De Blainville.

In the third chapter of the second part of the second volume of the "Recherches," Agassiz established the genus *Macropoma* for the fishes discovered by Mantell; and he describes the characters of the new genus and discusses its relations in the following terms:—

"It is incontestable that this genus has striking affinities with the genus *Cœlacanthus*. The body is similarly thick, and the fins have a like arrangement. There are, as in *Cœlacanthus*, two dorsal fins, one of which lies opposite the interval between the pectorals and the ventrals, and the other opposite the space between the ventrals and the anal. The second dorsal is supported by a very strong bone, which is also found in many other genera of the family. The caudal is largely

\* "It may seem scarcely credible that a part of such delicate structure should be preserved in a mineralized state, yet the fact is unquestionable. I have three specimens in my collection in which it is clearly shown."

developed, and greatly surpasses all the other fins. The scales also present a certain resemblance to those of *Cælacanthus*, in size as well as in form. But, on the other hand, the structure of the rays is very different; their cutting edges are beset with spines, and they doubtless served as protective weapons to the animal, while those of the *Cælacanthus* are smooth. The skeleton is strong, but I have not been able to satisfy myself whether the bones are hollow or not."

#### MACROPOMA MANTELLII, Agass.

" . . . . . The head is very large; it equals more than one-fourth of the length of the body; its bones are strong, and their surface is finely dotted. In the specimen figured in Plate 65 a, the roof of the cranium, the bones which surround the orbit, the jaws, a part of the opercular apparatus, the branchial arches, and a part of the thoracic girdle are readily distinguishable in their natural relations.

" The lower jaw has a very irregular outline; its dentary edge is grooved in front, and descends towards its articulation with the os quadratum. The pterygopalatine arch is very wide, especially behind. It is the palatines and the vomer which carry the largest teeth. On the other hand, the superior maxillary, which forms the edge of the upper jaw, has none.

" The fore part of the head [*front*] is concave, and rises as a rounded projection above the orbit. The posterior suborbital is a large osseous plate, granular on its surface like the cranium; the anterior suborbitals are elongated. The operculum has its posterior edge rounded. The branchial arches are very large and strong, whilst the thoracic girdle is proportionably weak. As in the pike, this arrangement is doubtless calculated to facilitate the deglutition of a large prey.

" The scales are large, and envelope the whole body in a thick cuirass, which appears to extend very far on to the caudal, judging by the impressions observable upon the lower lobe of the tail. The surface of all the scales is granulated, and this granulation is so persistent as to be recognizable when the scale is much worn. I have represented in Plate 65 b, fig. 1, a portion of the body of a fish which I believe to be the young of the same species, and whose scales are in so perfect a state of preservation that their minute structure may be studied in detail. They have for the most part a rhomboidal form, at least they appear thus when superposed (as in nature). Isolated they present a very different form, when the root of the scale is preserved, as in fig. 3, Plate 65 b. Examined with a lens it is seen that the superficial rugosities are produced by a quantity of little elongated tubercles, or rather of small pointed cylinders, which cover all the visible part of the scales. The largest and longest are, in the middle of the scale; those at the sides are shorter and more slender: the covered part of the scale is completely deprived of them; it is smooth, and exhibits only the lines of growth (Plate 65 b, fig. 3). For the rest there is no very marked difference among the scales of different parts of the body.

" . . . . . I have not succeeded in discovering any trace of the lateral line; doubtless the superficial tubercles prevent the mucous canals from being recognized.

" The fins present peculiarities no less singular than those of the scales. All the rays are stiff and very stout; they do not dichotomize, and are not jointed; but on each side they are beset with a series of strong spines, turned towards the extremity of the ray. Their bases are divided into two branches, so as to form a cleft which embraces the apex of the interspinous bone. At least,

the dorsal fin rays are constructed in this manner . . . . . There are two dorsal fins ; the first is situated immediately behind the pectoral girdle ; its rays are long and very strong. The second, situated opposite [*en face*] the anal (Pl. 65 a), has rays which are less robust, shorter, and more numerous, borne by a great bifurcated interspinous bone. In this specimen the fin has not fewer than 13 rays. The ventrals and the anal are nearly of equal size ; the ventrals are opposite the middle of the space comprised between the two dorsals ; the anal is rather further back than the second dorsal. Both are composed of very short, but strong rays.

“The caudal is extremely broad, and if, as everything seems to show, it is entire in the specimen (Pl. 65 a), it offers a most curious type of structure, a kind of great fan, all of whose rays appear to be equal. It is probable that it was rounded, as in certain Sauroids, at least no difference is observable between the upper and the lower rays. This fin is, in addition, supported in equal proportions by the superior and inferior caudal spinous processes, and the vertebral column is nowise bent upwards, as is the case in all the inæquilobed Ganoids. Its rays are very strong. I have counted some twenty in the lower, and a few more in the upper lobe. All are nearly equal, and only the anterior ones, situated at the base of the fin, are a little shorter. Their structure is the same as in the other fins, that is to say, the visible part of the ray is supported by a shorter ray, which is itself supported by the spinous processes of the vertebræ. The greater part of the caudal vertebræ thus afford support to the caudal fin, and it is this which gives the fin its great width.

“The internal skeleton of our *M. Mantelli* is in general robust. The apophyses are short but large, at least in the neighbourhood of the tail ; those of the abdominal vertebræ are longer, and bent more backward. The vertebræ, on the other hand, are small and delicate relatively to the size of the fish.

“But our knowledge of this remarkable fish is not limited to the skeleton ; many of the soft parts are also preserved. Among others, there are, in Mr. Mantell’s collection, many specimens of the trunk in which the stomach is distinctly recognizable. (Pl. 65 c, fig. 1, and Pl. 65 d, fig. 1.) It resembles a squamose cylinder, an appearance which is evidently the result of the changes which have taken place in the different membranes which compose its walls ; vascular trunks can even be perceived. These remains are commonly accompanied by coprolites, which have evidently been formed in the intestine. They have a general resemblance to those of Sauria, and are sometimes grooved in the same way. I have represented a series of them in Plate 65 a, to show the variety of forms which they affect. It is these coprolites which have been described by many authors as petrified firmcones.” (P. 177.)

In the explanatory notes which follow Prof. Agassiz speaks of the “bassin,” without describing it, and of the “plaque qui tient lieu de rayons branchiostègues.”

When Professor Agassiz published his “*Monographie des Poissons Fossiles du Vieux Grès Rouge*,” his views respecting the systematic position of *Macropoma* appear to have undergone considerable change. Thus he observes, at p. 61 :—

“J’ai déjà fait remarquer que le genre *Macropoma* de la craie, ainsi que le genre *Undina* de M. le Comte de Münster, cadrent mal avec les

autres Célacanthes . . . . . C'est dans l'Old Red et dans l'houille que la famille des Célacanthes acquiert son plus haut degré de développement ; passé cette époque elle décline rapidement, et son dernier représentant, qui d'ailleurs est fort douteux, appartient à la craie."

In 1849 Professor W. C. Williamson gave an account of the structure of the scales and the walls of the ossified air bladder of *Macropoma* in his valuable memoir "On the Microscopic Structure of the Scales and Dermal Teeth of some Ganoid and Placoid Fishes," published in the Philosophical Transactions for that year.

Professor Williamson shows that the tubercles which ornament the scales and opercular plates of *Macropoma* are composed of layers of kosmine coated with ganoin, and resting, in the case of the operculum, upon lamellæ of bone, in that of the scales, upon a lamellar substance which contains no lacunæ, but presents layers of irregular tubes interposed between the lamellæ. Successive layers of the tubes cross one another in direction.

At the base of each tubercle, whether on the operculum, or on the scale, there is a cavity, which communicates by one or more canals with the exterior.

The walls of the structure called "air bladder" by Mantell\* (who seems to have considered the solidity of the parietes of this organ to result from mineralization) and "stomach" by Agassiz, are proved by Professor Williamson to be composed of lamellæ between which are developed large lacunæ, identical with those found in the endoskeleton of the fish. Some of the external lamellæ lose their exact parallelism with those below, and one in particular assumes an undulating arrangement. On both sides of the folds of its undulations large irregular lacunæ are placed. This again is invested by other dense and apparently structureless lamellæ, which fill up the inequalities of the undulating layer, and form the external smooth surface of the organ.

With respect to the functions of this apparatus, Professor Williamson remarks:—

"I am disposed to believe that it has been an organ fulfilling the functions of an air bladder. Its osseous structure would render it capable of resisting a considerable amount of pressure ; and if its patu-

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\* In the Medals of Creation, 1844, Mantell gives up his first interpretation, and adopts that of Agassiz, but in "The Petrefactions and their Teachings," 1851, p. 437 he writes:—"Air Bladder (or Stomach?) of the *Macropoma*.—In every example of this fossil fish that I have dissected, there lies within the body, generally nearest the upper or dorsal part of the cavity, a long hollow cylindrical substance, often 7 inches in length, and 1½ inches in diameter, covered with a thin, brittle, scaly integument, which readily separates into two or three laminæ. The anterior part of this organ, which lies close to the posterior margin of the opercular bone, is always imperfect, appearing as if torn or ruptured ; the caudal extremity terminates in a *cul-de-sac*. From the situation and structure of this viscus I supposed it to be an air bladder, and described it as such in the "Fossils of the South Downs," in 1822, but on Professor Agassiz's visit to my museum at Brighton, that eminent naturalist pronounced it to be the stomach. Recent microscopic investigations of the investing integument have, however, tended to establish the correctness of my original interpretation of the nature of this remarkable body."

lous extremity has been closed up by an elastic membranous appendage capable of acting as a valve, this would enable the creature to regulate its buoyancy, by increasing or diminishing the compression of the contained air, and thus facilitate its movements in either shallow water or at great depths. Except in cases of diseased ossification, the existence of an internal thoracic or abdominal viscus having hard parietes of true bone, is an anomaly which, as far as I am aware, has hitherto presented no parallel in nature."

Professor Williamson finally remarks that the structure of—

"The scale of *Macropoma*, as now described, is wholly different from that presented by any of the ganoid fish noticed in the preceding pages [*Lepidosteus*, *Lepidotus*, *Semionotus*, *Pholidotus*, *Ptycholepis*, *Dapedius*, *Palæoniscus*, *Gyrodon*, *Aspidorhynchus*, *Accipenser*, *Platysomus*, *Megalichthys*, *Diplopterus*, *Holoptychius*\*]. It bears a much closer resemblance in its leading points to the dermal appendages found amongst the group of true Placoids, between which and the Ganoids *Macropoma* appears to form an inosculating link." (L.c. p. 464.)

In 1857, Sir Philip Egerton described and figured the specimen named *Macropoma Egertoni* by Agassiz, in the ninth of our "Decades," Pl. 10. This fossil, which was obtained from the Gault of Speeton, Yorkshire, exhibits only the anterior half of the fish, comprising the head, the pectoral fin, and the first few rays of the dorsal fin.

"The inclination of the profile line of the head is very steep from the occiput to the orbit, far more so than in the allied species; the orbit is situated in a more advanced position, and the facial line thence to the snout falls much more rapidly. The orbit in this species is large, and a portion of the capsule of the eye is preserved. The frontal bones are wide, coarse in texture, and bear a few scattered granules on their exterior surface. The borders of the upper jaw are formed of the superior maxillary bones, which are very broad; they are beset with very numerous sharp-pointed teeth, closely arranged, and of uniform size. The lower jaws are also very broad, and the space between the rami is closed by a single glossohyal plate, as in *Lophiostomus*, *Arapaima*, and *Amia*."

As regards the scales, Sir Philip Egerton remarks that—

"The surface ornament is very different; instead of the distinct tubercles so characteristic of that species (*M. Mantellii*); it is composed of minute granules united into longitudinal rows, with only a few small tubercles interspersed occasionally on some of the larger scales."

I venture to doubt that this fish belongs to the genus *Macropoma*, for the following reasons:

1°. The upper contour of the skull is quite unlike that which is seen in *Macropoma* and appears to be characteristic of the *Cœlacanth*s in general.

2°. In no *Macropoma*, and in no *Cœlacanth*, however well preserved, have I seen any trace of an ossified capsule of the eyeball.

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\* This is not the true *Holoptychius* of the Old Red, but a distinct genus, *Rhizodopsis*.

3°. The jugular [glossohyal] plates of *Macropoma*, as of all Cœlacanth, are double and not single.

4°. The shape of the lower jaw is quite different from that which is so characteristic of the same part in *Macropoma*, and the maxilla and other bones of the face are very different.

5°. The figure clearly displays several strong osseous ribs, while neither in *Macropoma*, nor in any other Cœlacanth, have such ribs been observed.

6°. The pectoral fin, judging by the disposition of its fin rays, does not seem to have been lobate, and the fin rays themselves appear to be articulated throughout, and not entire at their proximal ends, as in *Macropoma*.

I conceive the evidence adduced to be sufficient to prove that "*Macropoma*" *Egertoni* is not a "*Macropoma*," and indeed not a Cœlacanth at all. I therefore propose the generic name of *Eury-poma* (suggested to me by Sir Philip Egerton) for the fish, retaining the specific title of *Egertoni*.

In a note appended to the description of this fish, Sir Philip Egerton states that he has received from Mr. Beckles "a specimen of a "*Macropoma* found in the quarries of Purbeck stone near Swanage. The specimen is not sufficiently perfect to determine the species; it seems to be a shorter and deeper fish than *Macropoma* "*Mantellii*." I presume that this is the specimen to which Dr. Mantell refers (*Wonders of Geology*, p. 359).

The passages which I have quoted include, I believe, all the statements of any importance which have been published respecting the organization of *Macropoma* *Mantellii*. I propose to supplement the information which they contain by the following remarks upon the structure of the skeleton of this fish.

*The Spinal Column.*—This is as completely devoid of ossified vertebral centra as in other Cœlacanth, and its structure exactly corresponds with that of the corresponding region in them (Plate VII., fig. 1).

The neural arches and spines are continuously ossified, and the former embraced the persistent notochord as in a fork. There are no bony ribs,\* but the tail is provided with subvertebral bones, which closely resemble the neural arches and spines.

*The Median Fins.*—No specimen which I have met with shows a terminal prolongation with small fin-rays, but in other respects the caudal fin is similar to that of *Cœlacanthus* and *Undina*.

The anterior margins of the fin-rays of the median fins present

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\* The only specimen of *Macropoma* in which I have observed the slightest indication of ribs, is No. 25,782 in the British Museum. In this example four or five elongated bones lie on the left side and partly covered by the walls of the air bladder; but it is impossible to be certain that they may not be displaced neural spines. In *Holophagus* there are impressions of a few short rib-like bones below the posterior part of the dorsal region of the vertebral column.



near their bases a shallow groove, in which series, at first single, of rounded pits appear. In each of these pits a short pointed spine is fixed.

More towards the distal end of the fin-ray the rows of pits and spines become double, those of the two sides usually alternating. In no specimen I have met with does a fin-ray present any indubitable articulation. It is probable that the extreme ends were articulated, but the length of unjointed fin-ray is remarkable in *Macropoma*, as compared with *Holophagus* and *Cœlacanthus*.

The first dorsal fin is supported by the single lamellar interspinous bone (Plate VII., fig. 1), which is as characteristic of the *Cœlacanthus*, as the forked interspinous bone of the second dorsal (Plate VII., fig. 1), indicated by Agassiz. The true form of the first dorsal bone is best exhibited in No. 4,260 of the British Museum, which shows it to be plough-share shaped, the anterior margin being oblique, and much longer than the posterior. Several ridges radiate from its upper edge downwards and forwards to its anterior inferior angle and inferior edge.

*The Pectoral and Ventral Fins.*—The pectoral fins are supported by a very strong bone, curved so as to be concave forwards, flattened from side to side, and giving off a process upwards and backwards, so as to appear bifurcated above. (Pl. VII., fig. 4 b.)

The ventral end of each pectoral arch widens out in a direction transverse to the axis of the body, and becomes concave from side to side behind, so that this part of the bone takes on much the appearance of a marrow spoon. This is particularly well seen in No. 4,251 of the British Museum Collection.

I have met with only one specimen of the chalk *Macropoma* which shows the structure of the pectoral fin distinctly. In this (Coll. British Museum, 4,258) the right pectoral is thrown forward, and seen from the inner side (Plate VII., fig. 5). The rays, about 20 in number, decrease in strength from before backwards, and their inner ends are so arranged as to show that they fringed an obtuse lobe. On this no trace of scales was discernible, but the left pectoral, which is imperfectly preserved, shows the remains of a covering of small scales with a tuberculated ornamentation.

The pelvic bones are very long, and each has, at its base, a strong process directed at right angles to the axis of the bone, and meeting its fellow of the opposite side (Plate VII., fig. 1).

There is a specimen showing a ventral fin in the British Museum (No. 25,944), in which the fin-rays are so disposed as to lead me to believe that it was lobate.

The fin-rays of the paired fins do not seem to have possessed the spinous ornamentation along their anterior edges, which is seen in the median fins.

*The Skull.*—The roof of the skull (Plates VII., fig. 1, VIII., fig. 2), is divisible in *Macropoma*, as in *Cœlacanthus*, into two moieties, an anterior or frontal (B), and a posterior or occipito-

parietal (A) which meet at an obtuse angle, the occipito-parietal moiety being nearly parallel with the base of the skull, while the frontal slopes obliquely forwards and downwards to the snout; the occipito-parietal portion is slightly convex from before backwards, and more so from side to side; while the frontal portion, though convex from side to side, is slightly concave from before backwards.

Viewed from above, the occipito-parietal shield (A, fig. 2, Pl. VIII.) has a trapezoidal form, being more than twice as wide behind as in front, in consequence of the production of its posterolateral angles. A median sutural line distinguishes it into two halves; and, in the specimen represented in fig. 1., Pl. VIII., what appears to be a true suture runs obliquely from the median suture outwards and forwards to the outer margin of the parieto-occipital shield, cutting off a large triangular plate of bone, which appears to represent the so-called "*squamosal*" and the *suprascapular* (*S. Sc.*) of ordinary fishes from the proper parietals (*Pa.*)

The sculpture of this part of the roof of the skull presents the form of reticulated ridges and grooves, directed more or less transversely, with interspersed dots and splashes of enamel.

The frontal shield (B, fig. 2, Pl. VIII.), similarly viewed from above, is rounded in front, somewhat constricted in the interorbital region, and truncated behind, where it joins the parietals.

Like the posterior shield, it is divided by a median longitudinal suture, and in the specimen figured in Pl. VIII. it presents indications of the existence of a transverse dentated suture at its most constricted part.

In the same specimen, which is perhaps young, the proper frontal bones appear to be very narrow, the outer third of each being formed by a fringe of apparently distinct marginal ossicles (*x*); but these seem, eventually, to become completely united with one another, and with the frontals. The surface of the frontal shield exhibits a pitted and reticulated sculpture, like that of the occipito-parietal, which is most distinct on the marginal ossicles. The dots of enamel are scanty, and scattered at wide intervals.

The *basis cranii* (*a, b, c*) is formed by a layer of bone, which is continuous, and presents no trace of sutures, between *a* and *b*. Behind *b* it is defective for some distance, but reappears in front of *c*. It doubtless represents, in the greater part if not the whole of its extent, the *parasphenoid* of ordinary fishes.

Between the orbits this *parasphenoid* has the form of a stout bar of bone, grooved above, convex and smooth below; but it becomes flattened out from above downwards, both anteriorly and posteriorly. Anteriorly, it ends as a spatulate plate (Plate VIII., fig. 3*a*), which has prominent lateral margins, bounding a transversely concave under surface, over which are scattered multitudes of minute granular teeth, those on the margins of the plate being somewhat larger than the rest. The dentigerous plate may represent a vomer, but in no specimen that I have seen can it be distinguished from the *parasphenoid*.

Posteriorly, the parasphenoid is broken, but probably passed into the flat bony floor of the parieto-occipital division of the skull, which may either be an extension backward of the parasphenoid, such as exists in the sturgeon, or may be formed by coalescence of the latter with a true basi-occipital.

Above its spatulate dentigerous part, the basal bone passes upwards and outwards into strong lateral plates (Plate VIII., fig. 1, *Pr. f.*), which are concave outwards, and unite with the frontal shield. They represent the *prefrontals*.

Each prefrontal gives off from its anterior end, just above the rounded extremity of the dentigerous plate, a stout process (Plates VII., fig. 6, VIII., figs. 1 and 3, *d.*), which passes downwards and outwards, and ends by a free rounded extremity at the margin of the gape, close to the anterior end of the maxilla. This appears to represent the process of the prefrontal bone with which the palatine articulates in ordinary fishes.

The interorbital space above the parasphenoid, from the posterior margins of the prefrontals as far as a point a little in advance of the junction of the fronto-nasal and parieto-occipital shields, seems to have been devoid of ossifications answering to the orbitosphenoids and alisphenoids; but further back the sides of the parasphenoid pass indistinguishably into the *pro-otic* bones. Each of these is a large plate of bone, rising perpendicularly towards the roof of the skull, which it nearly reaches in front. Further back it sends out two great processes, one superior and the other inferior, at right angles to its own plane.

The superior process (Plate VIII., fig. 1, *e.*), curving outwards abuts against the under surface of the occipito-parietal shield, close to the middle of its outer margin, and furnishes an articular facet for the proximal end of the hyomandibular bone (Plate VIII., fig. 2, *H.M.*).

The superior process of the pro-otic is separated by a deep oval fossa from the inferior process (Plate VIII., figs. 1 and 2, *f.*), which is a stout plate of bone, convex from above downwards on its outer surface, and ending in front by a free thick edge, represented somewhat too round in Pl. VIII., fig. 2. The lower incurved edge of this scroll-like plate does not come into contact with the osseous basis cranii, which hereabouts begins to be defective.

The root of the superior process (Pl. VIII., fig. 1 *e.*) separates two slit-like foramina which lead into the interior of the skull, and probably gave exit to divisions of the fifth nerve. From the upper and external edge of the inferior process a vertical bar of bone is sent off and, abutting against the superior process, bounds an oval fossa behind.

Externally and posteriorly, the pro-otic abuts, by an abruptly truncated and perpendicular face, against another stout lateral osseous mass (*g.*), which appears to represent the *opisthotic* and *exoccipital*. From this three processes pass, one ascending, which lies against the vertical bar (*f*<sup>1</sup>) of the pro-otic; a second external and ascending process (Pl. VIII., figs. 1 and 4, *h.*) passes upwards and backwards to unite with and support the supra-scapular part (*S. Sc.*) of the parieto-occipital shield. The third process (Pl. VIII., figs. 1 and 4, *i.*) is

directed outwards from near the base of the skull (perhaps arising chiefly from the parasphenoid), and ends in a free obtuse surface, against which the middle of the hyomandibular suspensorium abuts (Pl. VIII., fig. 2). Behind the part from which these processes are given off, the opisthotic and exoccipital ossification is continued backwards as a vertical plate, which forms a large part of the postero-lateral walls of the cranial cavity. Between this plate and the processes of the opisthotic there is a deep fossa, floored below by a thin plate of bone (Pl. VIII., fig. 4 *k*) which forms a sort of continuation of the lower edge of the third process of the opisthotic (*i*) into the base of the skull.

The lateral "exoccipital and opisthotic" plates do not reach the roof of the skull superiorly, but end in a free edge, posteriorly; they diminish to a height of not more than one-eighth of an inch above the base of the skull. From the point where it is lowest (Pl. VIII., fig. 4 *l*) the base of the skull rapidly diminishes in breadth, and ends at *c*, by a free rounded extremity, which is so fractured that its precise shape is not determinable.

A thin plate of bone (Pl. VIII., fig. 4 *m*) forms a low arch over this part of the skull, and is continuous with the basal plate below.

It is not improbable that this arch may represent an anterior vertebra corresponding with one of those which, in the *Ganoidei*, commonly coalesce with the occipital region of the skull.

The pro-otic bones of opposite sides are not separated by a greater distance than the width of the presphenoidal bone in front and below, but, above, they are somewhat more distant.

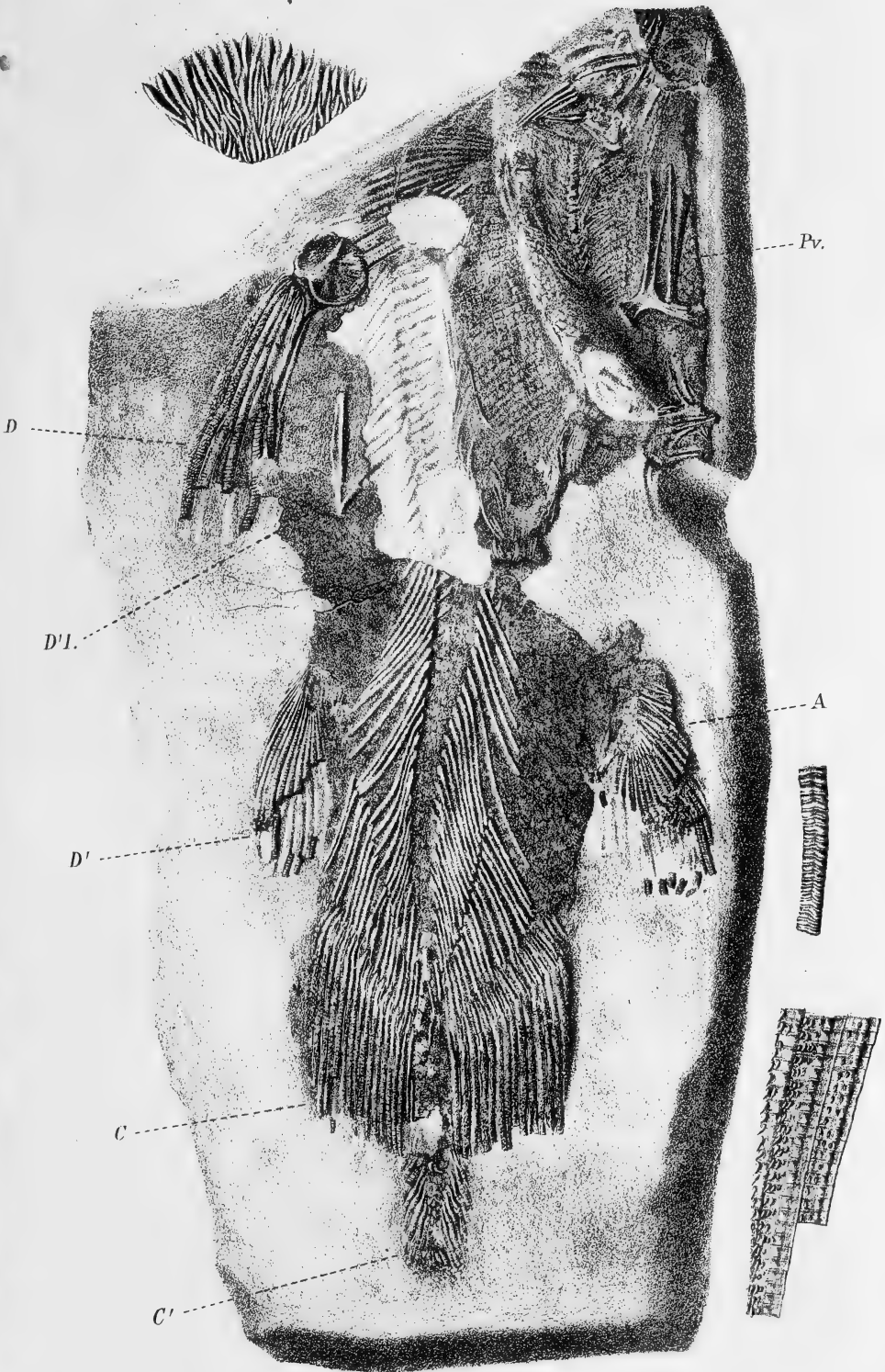
The anterior end of the snout of *Macropoma* is constituted by a single bone having the form of a triangle with its base downwards, with a convex anterior and concave posterior surface (Plate VII., figs. 3, 4, and 6). The convex face is beset with small cylindrical teeth, but at the postero-lateral angles of the oral, or lower, margin of the plate, several larger curved and pointed teeth are attached.

The posterior concave face is smooth, and seems to have played over the ethmoidal cartilage.

This bone may either represent the *premaxillæ* coalesced, which is the interpretation that first suggests itself; or, on the other hand, it may be a *vomer*, such as would be formed if the vomerine teeth of *Lepidosiren* were supported upon a common bony base. In the latter case the *premaxillæ* remain to be discovered.

The hyomandibular, quadrate and pterygoid elements of the face are represented in *Macropoma* by a great triangular plate of bone, in which I have not been able to discover any distinct sutures. The outer and upper surface of this "pterygo-suspensorial" bone, and its general form, are well shown in fig. 3., Pl. VII., while the proper contour of the hinder half of its lower edge is seen in fig. 6 of the same plate. The inner surface of an entire pterygo-suspensorial bone is beautifully displayed in No. 4246 of the British Museum collection.

The whole plate is so twisted upon itself that, anteriorly, its surfaces look almost downwards and upwards, while posteriorly, they look inwards and outwards. The anterior angle is compara-

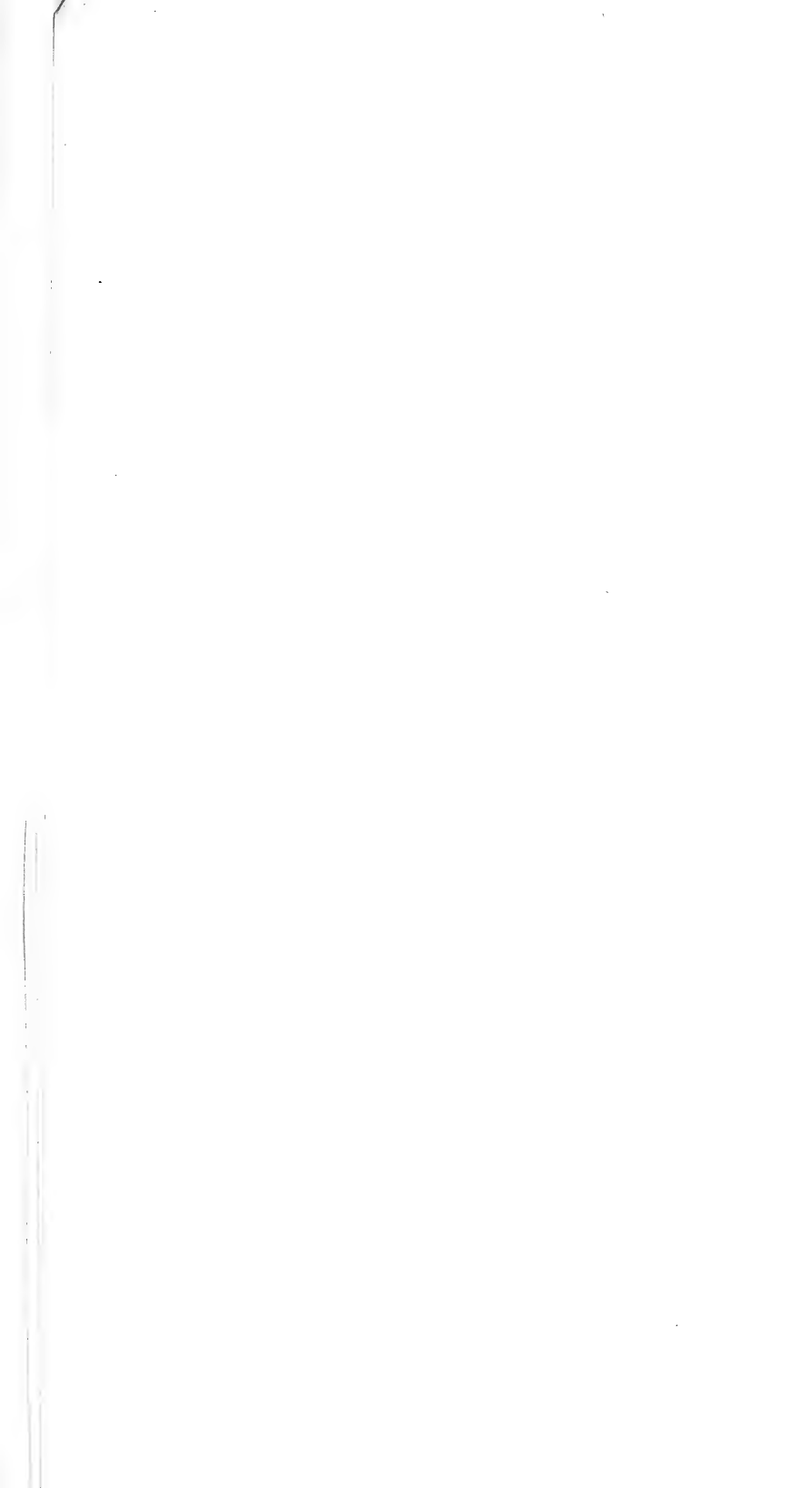


Dinkel del et lith.

Day & Son (Limited) Lith<sup>rs</sup>

*Holophagus gulo.* (Egerton.)









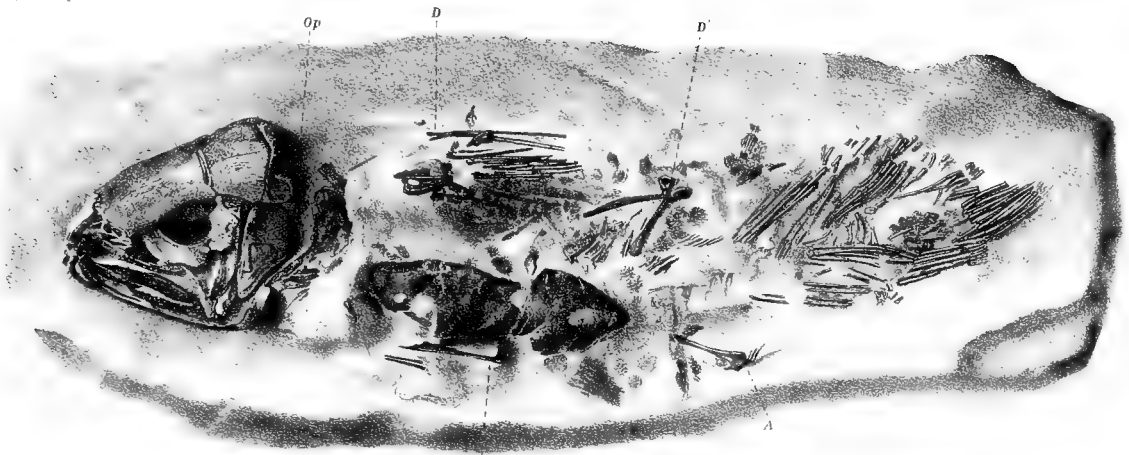


Fig. 1.

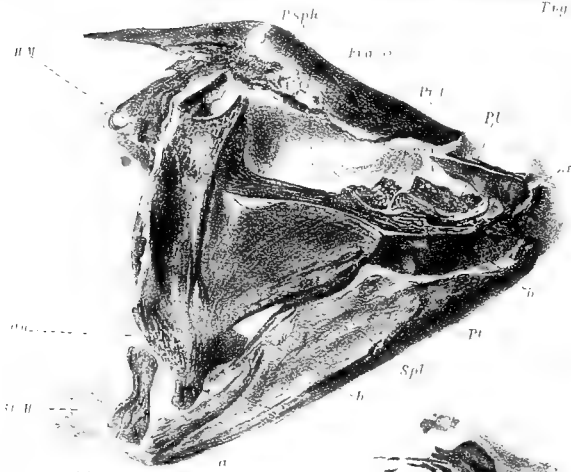


Fig. 2.



Fig. 3.



Fig. 4.



Fig. 5.



Fig. 6.

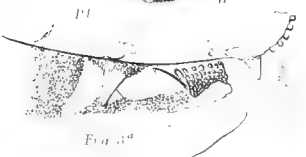


Fig. 7.



Fig. 8.

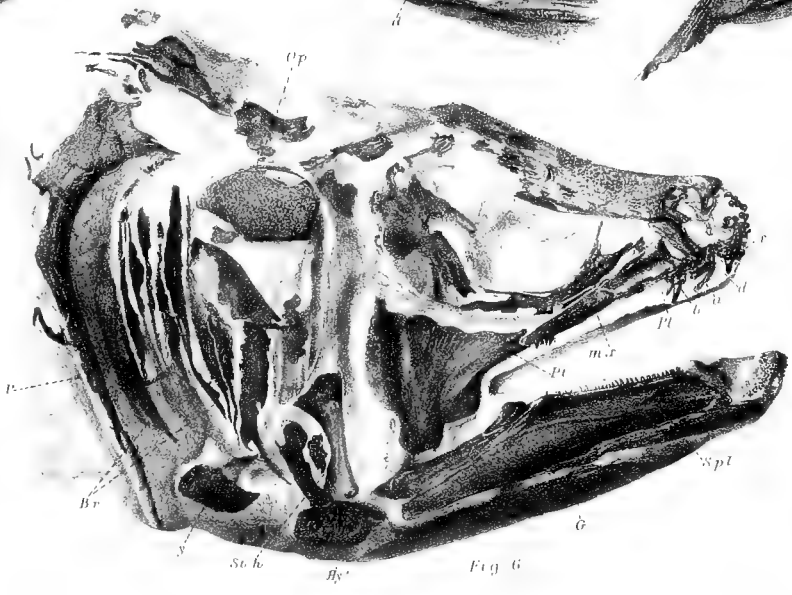
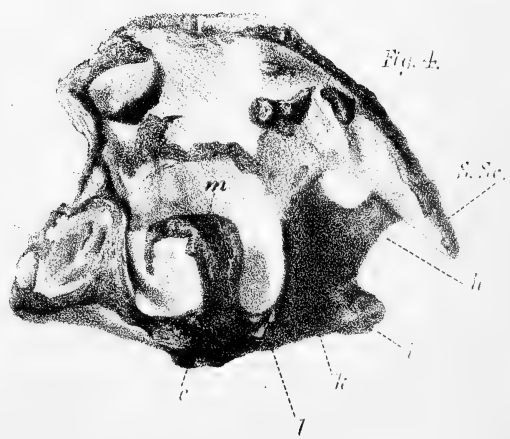
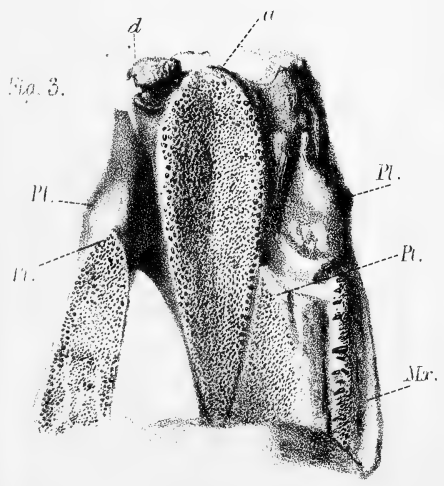
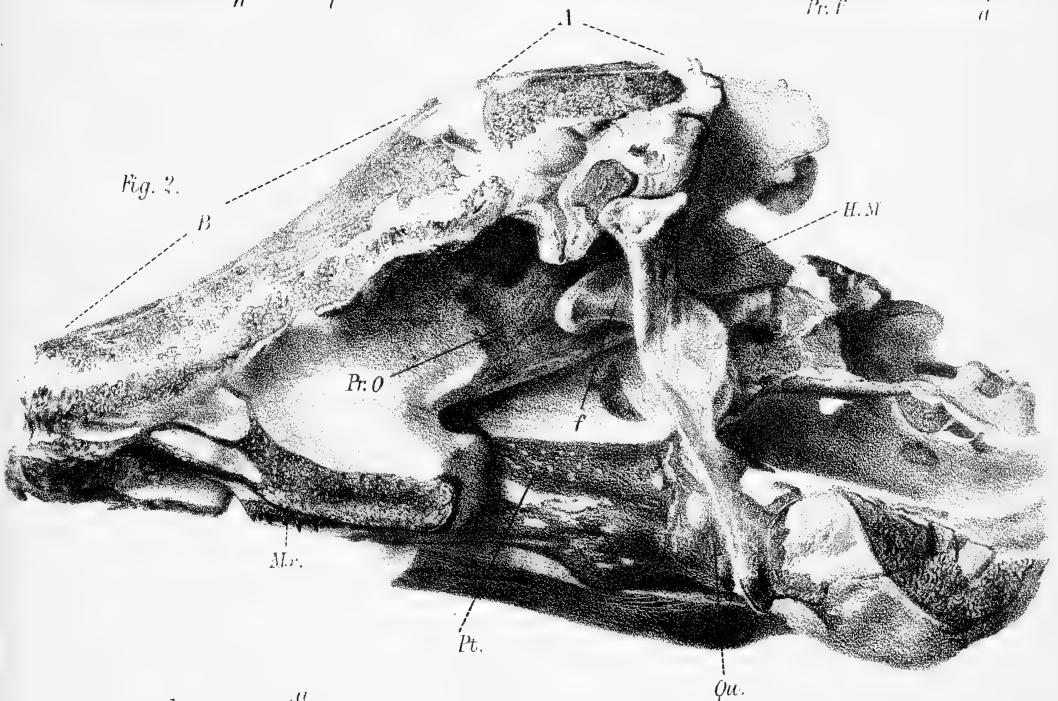
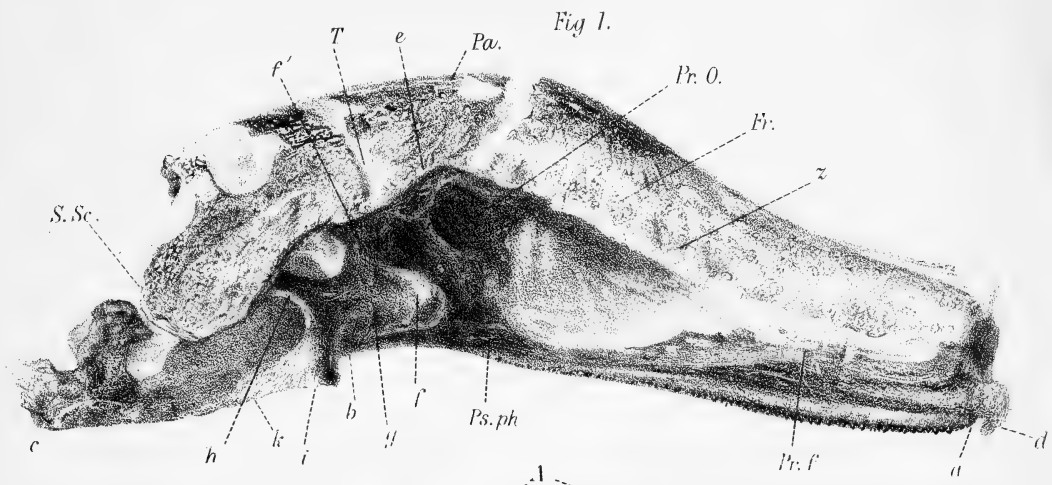


Fig. 9.

*Megapoma Mantelli* AGASSIZ



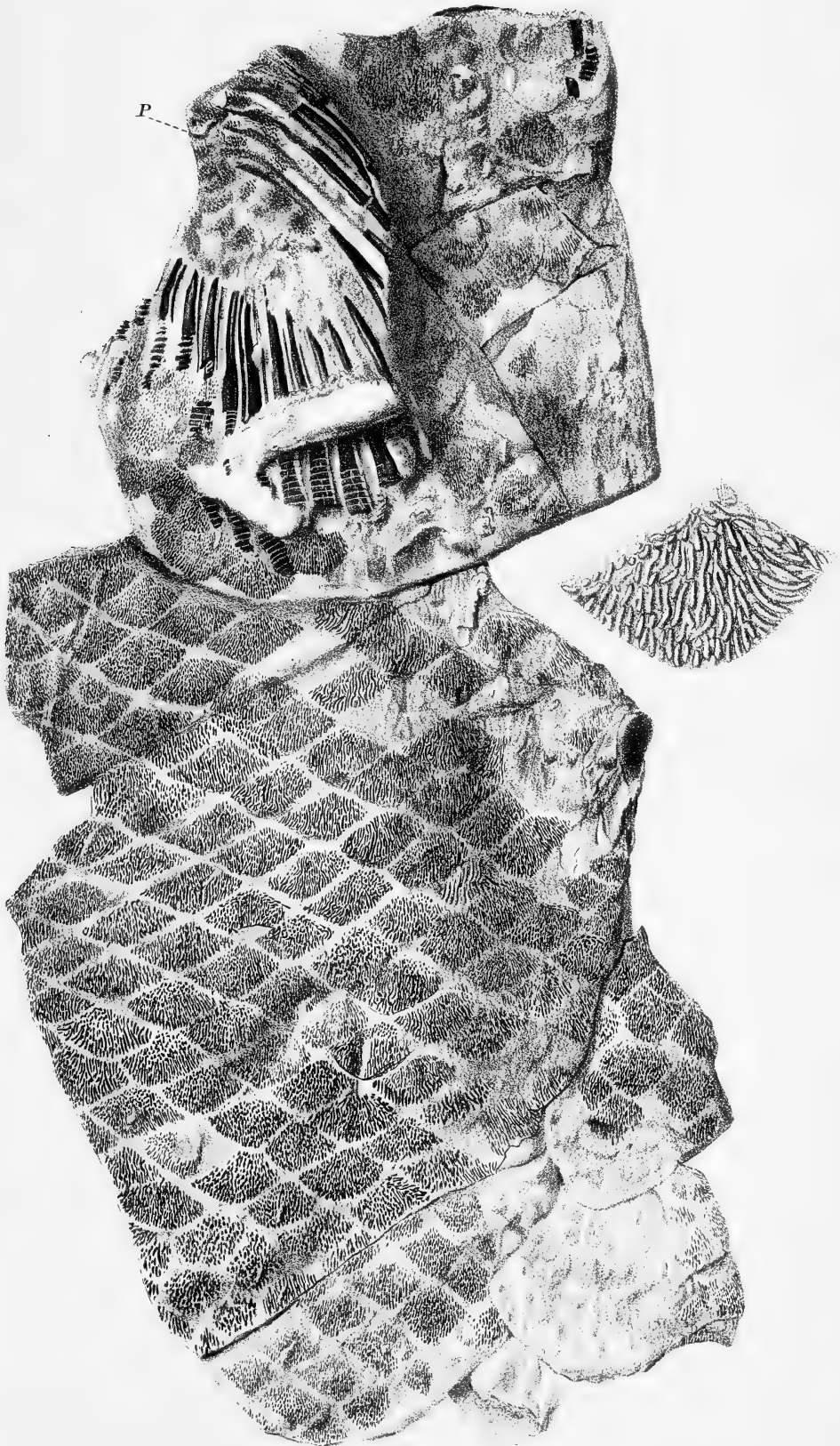


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Day & Sons Lith.

*Macropoma Mantelli (Agassiz.)*





*Macropoma substriolatum* (Huxley)



Fig. 1.

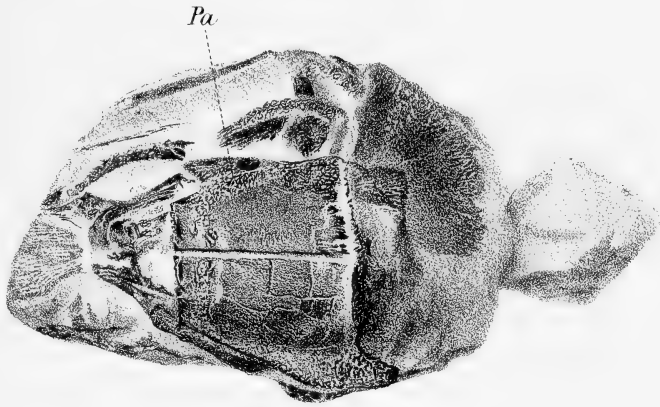


Fig. 2.

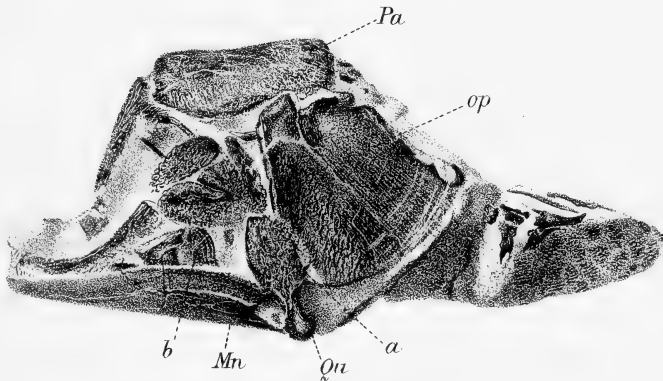


Fig. 3.

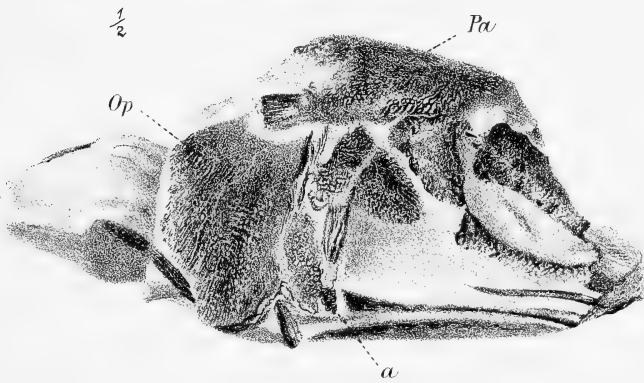
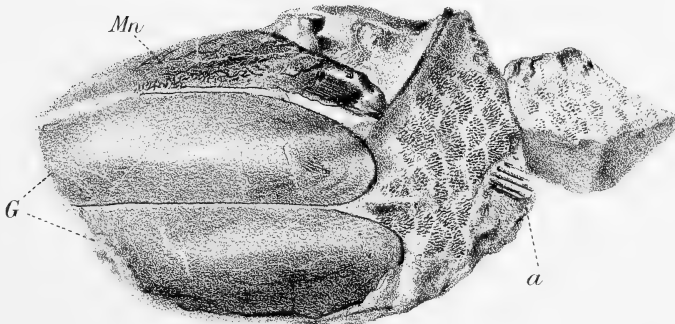


Fig. 4.







tively thin and rounded off, and extends forwards to the level of the prefrontals (Pl. VII., fig. 3; Pl. VIII., fig. 3), where it articulates with the bone, *Pl.*, which it underlies.

The posterior inferior angle is formed by a very stout neck which bears the transversely elongated condyle for articulation with the mandible. This condyle has a subcylindrical pulley-shaped articular surface, somewhat excavated in the middle, like the distal end of a humerus.

The upper and posterior angle of the bone, *H. M.* is likewise formed by a strong neck, which expands above into a broad head, and articulates thereby with the side walls and roof of the skull (Pl. VIII., fig. 2).

The outer and upper surface of this bone is remarkably smooth and polished. The inner surface, on the contrary, with the exception of a small strip belonging to the posterior part of the quadrate, is evenly covered with minute asperities, which have, for the most part, more the aspect of tubercles of enamel than of teeth. Along the outer edge, however, they become longer, sharper, and more tooth-like.

In Pl. VIII., fig. 3, the anterior end of the left pterygo-suspensorial bone is seen to pass to the ventral side of, and become connected with, the bone *Pl.*, which is convex from side to side below, and correspondingly concave above. The inner edge of this bone articulates with the prefrontal, and I conceive that it represents the *palatine*.

The concave upper surface of the right palatine is well seen in No. 4241 in the British Museum; and here again the bone is connected on the inner side with the prefrontal, and on the outer, with the anterior end of the pterygo-suspensorial. In the specimen represented in Pl. VIII., fig. 3, there are no teeth upon the oral surface of either of these bones; but I believe that such teeth existed, inasmuch as No. 4237 B.M., the head of which is represented in fig. 3, Pl. VII., shows, in the interior of the mouth, a convex plate, *Pl.*, covered with small teeth. In this specimen and in No. 4252 B.M. (Pl. VII., fig. 6) certain sharp, curved, conical teeth, *bb*, are visible, which certainly belong neither to the maxilla nor to the bone *x*, and may have been attached to the palatines.

The *Maxillæ* (Pl. VII., fig. 6; Pl. VIII., figs. 2 and 3) are slender bones which lie alongside the outer margin of the pterygo-suspensorial bone, and form the edge of the gape. Their lower edges are beset with small curved teeth. Their anterior connexions are not displayed in any specimen I have seen. Posteriorly, each abuts upon the apex of an elongated triangular "postmaxillary" bone which fills up the interval between the suborbitals, opercula, and mandible, and covers the quadrate articulation.

Each ramus of the mandible is very stout, and is deepest in the middle third of its length (Pl. VII., fig. 6), where its upper margin is nearly straight. Posteriorly, the upper margin diminishes in height rather gradually; but, anteriorly, it falls rapidly, being as it were excavated towards the symphysis.

In the mandibles, which are represented in Pl. VII., the greater part of the angular-articular and dentary elements have been broken away leaving only the plate which answers to the splenial of reptiles (fig. 3., *Spl.*) And it is this plate which gives rise to the height and straightness of the upper edge of the middle third of the ramus.

The angulo-articular element of the mandible, which forms the outer part, if not the whole, of the ramus at the articulation, rapidly diminishes in height, and leaves the outer surface of the splenial bare as it passes forwards. It then meets the dentary, fitting into a V-shaped space afforded by the latter.

The dentary, passing forwards, suddenly rises into a kind of shoulder, *y* (fig. 4, Pl. VII.), which applies itself to the anterior part of the outer surface of the splenial.

In uninjured specimens the whole outer surface of the angulo-articular is covered with tubercles of enamel. Similar, but more scattered, tubercles ornament the dentary; but the outer surface of the splenial, exposed between the process *y* and the front and upper margin of the angular-articular, is perfectly smooth.

There is a distinct suborbital half ring (Pl. VII., fig. 1), formed to all appearance of a single bone, or of several bones which have coalesced, and presenting a granular external sculpture. The posterior part of the suborbital ring is much broader than the anterior, and abuts upon the operculum, behind and below which it comes into contact with the triangular postmaxillary bone: in front and above it, exhibits a deep notch.

The ornamentation of the suborbital bones consists of pits and reticulated ridges, with scattered tubercles of enamel.

The *operculum* (Pl. VII., fig. 1, *op.*), is a large four-sided bone. Its upper margin is shortest; its front margin, which is as long as the distance from the roof of the skull to the lower edge of the triangular "post-maxillary" bone, longest. The posterior margin is much shorter, so that the lower edge of the operculum runs very obliquely, from above and behind downwards and forwards.

Traces of a *suboperculum*, much smaller than the operculum, are discoverable in some specimens.

When the outer surface of the operculum is complete, it is covered with close-set conical enamel tubercles, like those of the roof bones of the cranium.

Two large *jugular plates* occupy the whole interval\* between the rami of the mandible. The inner, opposed, margins of these plates are straight, the outer, evenly convex.

The *hyoidean arch* is strong and well ossified, and is connected with the hyomandibular by a very strong "*stylo-hyal*" (*St. h.*, figs. 3 and 6, Pl. VII.).

Each *branchial arch* is, apparently, a single arcuated bone, deeply grooved posteriorly. I can count only four on each side in the

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\* In No. 25,872, of the British Museum Collection, the surface of the jugular plates is perfectly preserved, and is ornamented with tubercles of enamel, which are set, evenly, and pretty close together, over its whole surface.

specimen (belonging to the Earl of Enniskillen), which best displays these structures.

The resemblance of the branchial apparatus of *Macropoma* to that of *Cœlacanthus* is still further increased by the large spatulate bone, which, in *Macropoma*, terminates the median part of the branchial skeleton posteriorly. No specimen has exhibited the anterior moiety of the median branchial skeleton, so that I am unable to say whether it has or has not the form of a crucial bone.

I have not been able to procure detached teeth of *Macropoma* for microscopic examination. The bases of even the largest teeth are perfectly smooth, and present no longitudinal grooves or foldings.

*Macropoma substriolatum*, Huxley (Plate IX. and X.).

I have abstained hitherto from referring to a specimen of a fossil fish to which Sir Philip Egerton refers in the following terms, in the note at p. 19 the "Preliminary Essay" of Decade X. :—

"In the Woodwardian Museum, at Cambridge, there is the head and part of the trunk of a *Cœlacanthus*, from the Kimmeridge clay at Cottenham. The head shows the frontals, prefrontals, and lower jaw, with the tympanic attachments. The glossohyal plate is double, as in *Holoptychius*. The scales are roughly undulate, coarser in pattern than in *Undina*, *Cœlacanthus*, and *Holophagus*, but not absolutely tuberculate, as in *Macropoma*. One fin is preserved, probably the left pectoral. It is lobate, broad, and strong. The operculum is triangular, the frontals short, and the prefrontals descend at an abrupt inclination."

Pl. IX. represents the ventral surface of the body of the *Cœlacanth* fish of which Sir Philip Egerton speaks, of the size of nature.

It is covered with large, thin, cycloidal scales, each of which is divided into a large smooth region, overlapped in front and on each side by the neighbouring scales, and a comparatively small free part, which presents numerous close-set elongated dots, or short ridges, of enamel. The dots and ridges are distinct, and their long axes are roughly parallel with that of the body, though the lateral ones sometimes show a certain tendency to diverge from the long axis of the scale itself.

The left pectoral fin (*P*) is very well shown, and exhibits, at fewest, fifteen fin-rays, the bases of which are so disposed as to inclose an oval "lobe," which is completely covered by small scales, not more than half, or a third, as large as those of the body, but possessing the same ornamentation.

The proximal ends of the fin-rays are unarticulated, but seem to be hollow; distally they become broader and flatter, and then narrow to points, without becoming longitudinally subdivided. Rather more than the distal half of each, apparently, was divided, transversely, into short broad joints.

The surfaces of these fin rays are quite smooth.

Four views (one-half the size of nature) of the head of this fish are given in Pl. X.; it is composed of a parieto-occipital and a frontal moiety, as in *Macropoma*, and the former (*Pa*) is divided by a median suture into two. The frontal shield is greatly crushed, and its precise form cannot be made out, but so much of it as remains is like that of *Macropoma*.

The general arrangement of the suborbital bone or bones (figs. 2 and 3) is plainly similar to that in *Macropoma*; and the same likeness extends to the operculum (*Op*), to the strong pulley-like end of the quadrate (*Qu*),—divided in the present fish by a longitudinal depression, so as to resemble the articular end of a phalanx,—and to the lower jaw.

I suspect that *b*, fig. 2, represents the *post-maxillary* bone of the Chalk *Macropoma*, in which case the flat bone *a* (figs 2 and 3) will probably be the *suboperculum*.

The jugular bones (fig. 4, *G*) are double, and closely resemble those of *Macropoma* in form: they present an ill-defined rugosity, but no proper sculpture, and no trace of enamel, resembling in this respect the opercula and the other bones of the head.

At *a*, fig. 4, clear traces of ossified branchial arches are visible.

In its general characters it is clear that this fish completely resembles *Macropoma*; and considering the frequency with which the enamel is found to have disappeared from the cranial bones of fishes of the latter genus in the Chalk, no weight can, I think, be attached to this apparent difference.

The scales are quite similar to those of *Macropoma* in form, and in the proportion of the sculptured to the unsculptured part (the unsculptured part in the scale 3 of plate 65 *b* of the "Recherches" is far too small), but the enamel tubercles are far less regularly oval, and tend to become elongated and ridge-like.

I think, therefore, that this may safely be regarded as a distinct species, for which I propose the name of *Macropoma substriolatum*.

I am indebted to Prof. Sedgwick and Mr. H. Seely, for the opportunity of figuring and describing the specimen on which this species is based.

*The common characters, classification, and distribution of the  
CÆLACANTHINI.*

The fossil fishes which have been described above under the names of *Cœlacanthus*, *Undina*, *Holophagus*, and *Macropoma*, have the following characters in common:—

1. The body is covered with thin cycloidal scales, the exposed portion of which is ornamented with tubercles or ridges of enamel.

2. There are two dorsal fins, the anterior supported by a single broad and plate-like interspinous bone; while the posterior has a forked interspinous bone. There is a single anal fin, and a very large caudal, the upper and lower lobes of which are equal; the spinal column, which traverses it without being at all bent up, ending in a filament with small supplementary fin rays.\*

In the caudal fin, interspinous bones are interposed between the fin-rays and the neural and subvertebral spines.

3. The paired fins are obtusely lobate. The pectoral arch is strong and well ossified, and there are two large pelvic bones. The fin-rays of all the fins are not articulated at their proximal ends, and are longitudinally undivided. The ventral fins are placed but very little behind the anterior dorsal, and the anal lies below the posterior dorsal.

4. The spinal column is unossified, the notochord being persistent, and only the neural and subvertebral arches ossified. If ribs existed at all, they were remarkably small.

5. The roof of the skull is formed by a parieto-occipital and a frontal shield, which meet at an obtuse angle. The surface of each of these is ornamented with tubercles of enamel.

6. There is a large "pterygo-suspensorial" bone representing the hyomandibular, quadrate, and pterygoid bones of ordinary fishes.

7. There are two jugular bones and no proper branchiostegal rays.

8. The branchial and hyoidean arches are well ossified, and there is a median bone in the branchial series which has a spatulate posterior termination (not observed in *Holophagus* and *Undina*).

9. The air bladder has ossified walls.

10. The teeth are for the most part "en brosse" or tubercle-like and minute; but a few are larger, acutely pointed (*Undina*? *Holophagus*?). These larger teeth exhibit no plications at their bases.

These being the common characters of the *Cœlacanthini*, the next point is to obtain clear definitions of the several genera which compose the group.

*Cœlacanthus* is readily enough distinguished from the rest by

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\* This peculiarity of the caudal fin has not been actually observed in *Macropoma*; but it is hardly doubtful that the cretaceous genus resembled the others in this particular.

the ornamentation of its scales, which is disposed in converging ridges, not in tubercles; by the ridged ornamentation of the rami of the mandible and of the jugular bones; and by the absence of spines upon the fin-rays of the median fins.

In *Macropoma*, on the other hand, the scale ornament is made up of distinct tubercles; the jugular bones and mandibular rami are covered with tubercles, not with ridges; there are single or double rows of stout spines upon the anterior edges of the fin-rays of the median fins, which are inarticulated through the greater part of their length.

In *Holophagus* the scale ornament is in ridges, like that of *Cœlacanthus*. There are small spines, sometimes in more than two rows, upon the fin rays of the anterior dorsal and both lobes of the caudal fins; but I see none upon the second dorsal or upon the anal. The median fin-rays are articulated through more than half their length.

Of the two species of *Cœlacanthus* (= *Undina*) described by Count Münster, *C. Kohleri* is distinguished by the ornamentation of its scales "resembling flies' eggs," and by the rows of small spines upon the fin rays of the first dorsal and caudal fins.

The beautiful specimen of this species, the property of the Earl of Enniskillen, which is before me, shows the first and second dorsal fins, the pectorals, and the ventrals; the tail is wanting. The fin-rays of the anterior dorsal are spinous, and the spines are set in a double row along the anterior edges of the fin-rays, much as in *Macropoma*, and unlike *Holophagus*. The fin-rays remain undivided much further from their base than in *Holophagus*, and in this respect, also, more resemble *Macropoma*.

The sculpture has disappeared from the cranial bones, and the inner sides of the two jugular bones are exposed, so that nothing can be said upon this point. The scales are represented by mere bony films.

The head is altogether similar in form to that of *Macropoma*. There is a well ossified parasphenoid. The stylohyal, the operculum, the pectoral arch, and the lower jaw, so far as they are preserved, are very like those of *Macropoma*.

The only teeth which are visible are small and granular, and resemble those of the pterygo-suspensorial and parasphenoid bones in *Macropoma*. The absence of pointed teeth is a circumstance of merely negative import, to which I am not disposed to attach any importance.

Of *Cœlacanthus* (*Undina*) *striolaris* I have seen no specimen, but while Münster's figures show that, in all important respects, it resembled *C. Kohleri*—he assigns to it scales with a striated ornamentation, and fin-rays without spinous ornamentation. Putting aside the teeth (the absence of sharp teeth in *Undina* and of granular teeth in *Cœlacanthus* not being proved), I see no character by which this species is separable from *Cœlacanthus*, while *C. Kohleri* appears to be equally indistinguishable from *Macropoma*.

If this supposition should be borne out by the examination of more perfect specimens of *Undina*, the genera of Cœlacanths would be reduced to three,—*Cœlacanthus*, *Holophagus*, and *Macropoma*; and, in the ornamentation of its scales and fin-rays, *Holophagus* would occupy the same intermediate position between the other two genera as it does in time. However, it is better, for the present, to retain *Undina* as a distinct genus.

Bearing in mind the range of the Cœlacanths from the Carboniferous to the Chalk formations inclusive, the uniformity of organization of the group appears to be something wonderful.

I have no evidence as to the structure of the base and side walls of the skull in *Cœlacanthus*, but the data collected together in the present Decade show that, in every other particular save the ornamentation of the fin-rays and scales, the organization of the Cœlacanths has remained stationary from their first recorded appearance to their exit. They are remarkable examples of what I have elsewhere termed "persistent types," and, like the Labyrinthodonts, assist in bridging over the gap between the Palæozoic and the Mesozoic Faunæ.

## DESCRIPTION OF PLATES—II. to X.

## PLATE II.

- Fig. 1. A specimen of *Celacanthus lepturus*, of the natural size. In the Museum of Practical Geology.  
 Fig. 2. The anterior part of the body enlarged.  
 Figs. 3, 4. Scales magnified.

## PLATE III.

- Fig. 1. *Celacanthus lepturus*, of the natural size.  
 Fig. 1a. Scales magnified.  
 Fig. 1b. Part of the ornamentation of the operculum magnified.  
 Fig. 2. The hinder part of the body of a *Celacanthus lepturus*, of the natural size, showing the remains of the ossified air-bladder.  
 Fig. 3. Under view of the head of a *Celacanthus lepturus*.  
 All these specimens are in the Museum of Practical Geology.

## PLATE IV.

- Fig. 1. Magnified view of the counterpart of the specimen represented in Plate III., fig. 3.  
 Fig. 2. The mandible of the same inverted.  
 Fig. 3. Under view of the head of a specimen in the collection of Edw. Binney, Esq., F.R.S.  
 Fig. 4. Pelvic bones of *Celacanthus lepturus*. In the Museum of Practical Geology.  
 Fig. 5. The two dorsal fins of a *Celacanthus lepturus*. In the Museum of Practical Geology.  
 Fig. 6. Caudal extremity of a specimen of *Celacanthus lepturus*. Magnified  $1\frac{1}{2}$  times.

## PLATE V.

- Figs. 1, 2, 3, 4. *Celacanthus elegans*. From specimens in the collection of Sir Philip Egerton, Bart.  
 Fig. 5. *Celacanthus caudalis*. In the collection of Sir Philip Egerton, Bart.  
 Figs. 5, 6. *Celacanthus elongatus*. In the Museum of the Geological Survey in Ireland.

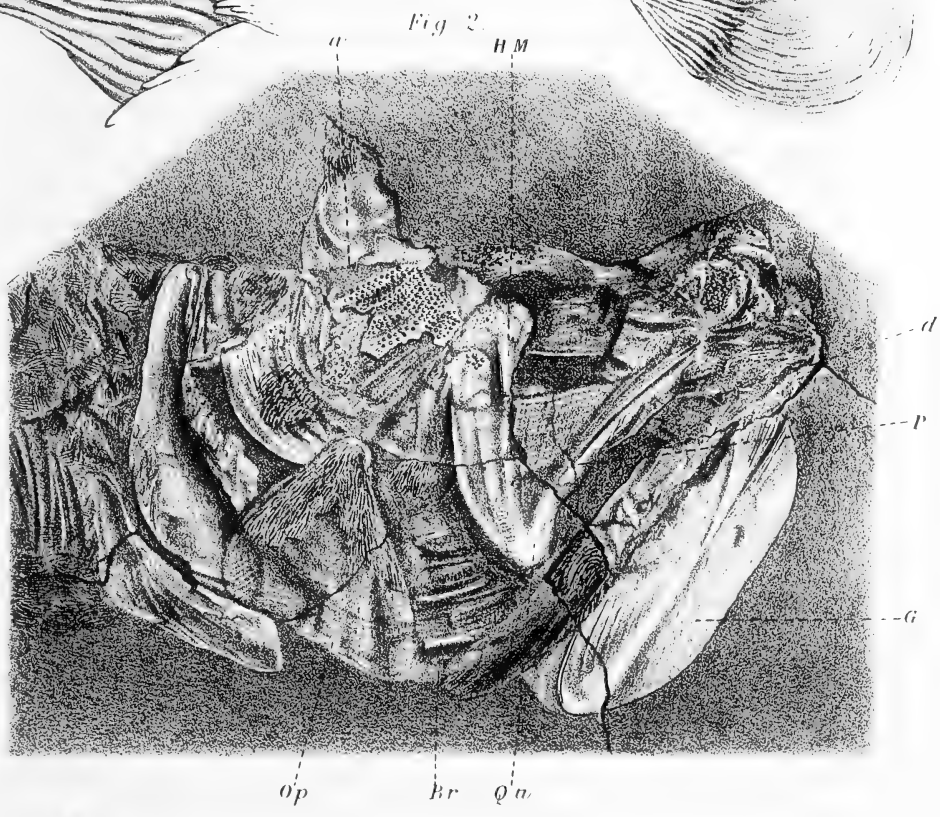
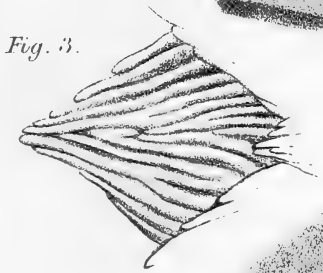
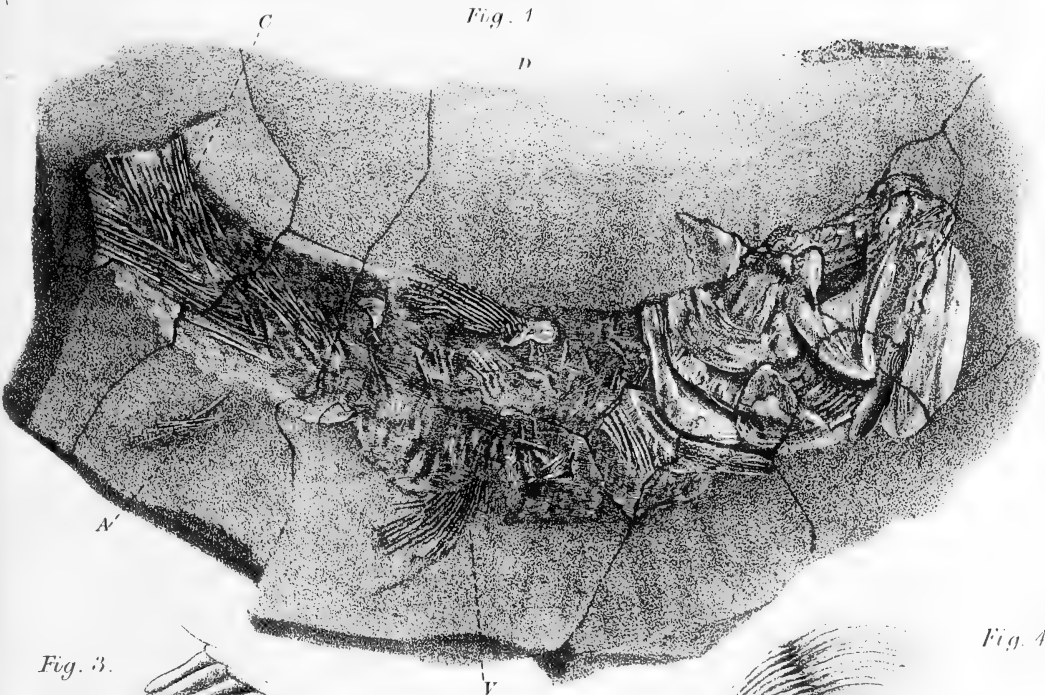
## PLATE VI.

*Holophagus gulo*, with a scale and fin-rays magnified. In the Museum of Practical Geology.

## PLATE VII.

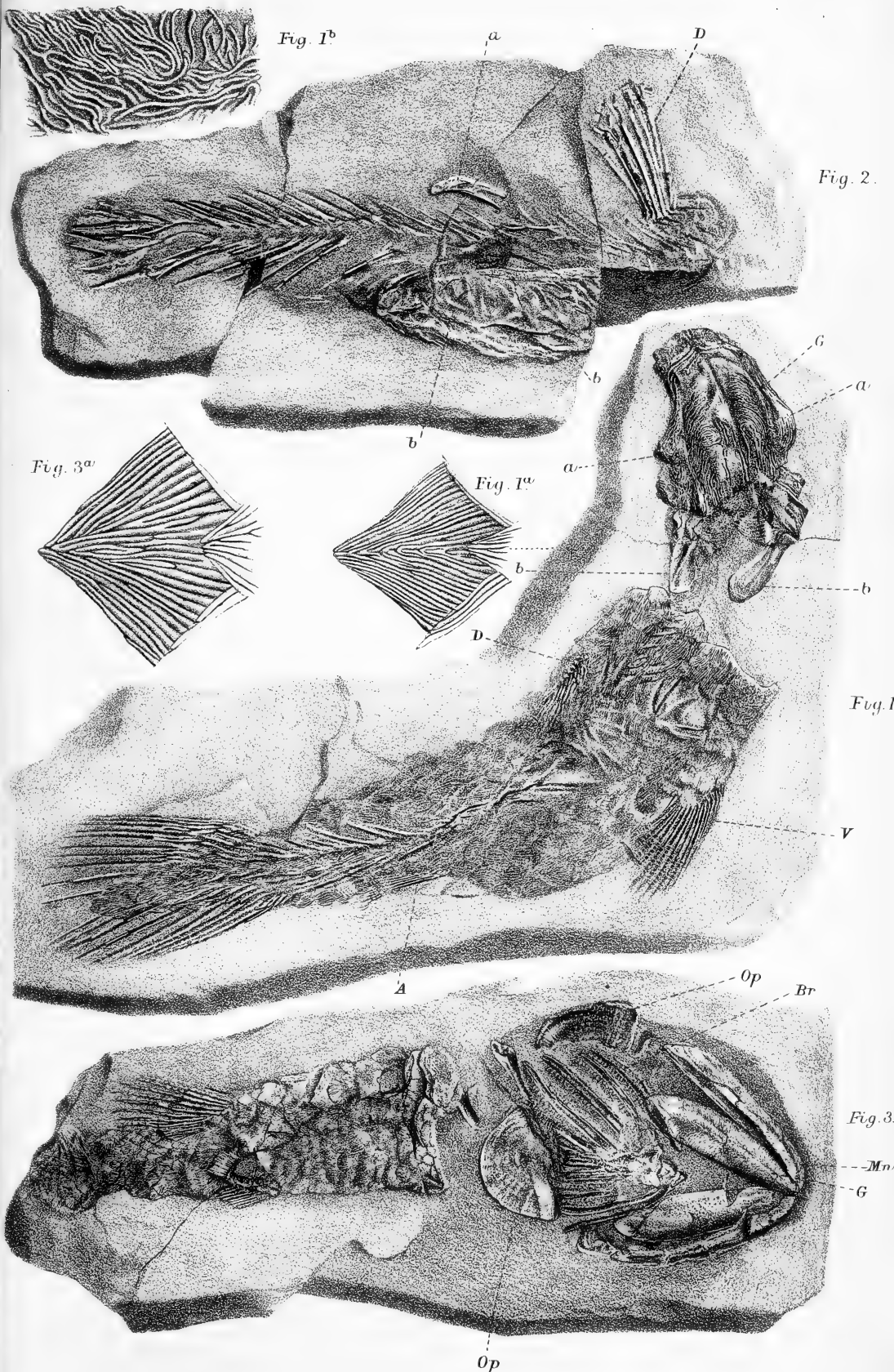
- Fig. 1. *Macropoma Mantellii*. One half the size of nature. In the Museum of Practical Geology.  
 Fig. 2. A detached air-bladder of *Macropoma Mantellii*. One-half the size of nature. In the British Museum.  
 Fig. 3. The head of *Macropoma Mantellii* figured by Prof. Agassiz, 'Recherches' II, Pl. 65 d, fig. 2, the matrix having been further cleared away.  
 Fig. 3a. The teeth enlarged. In the British Museum (No. 4237).  
 Fig. 4. A side view of the snout of the *Macropoma Mantellii*. Figured by Prof. Agassiz, l.c. Fig. 1. In the British Museum (No. 4,270).  
 Fig. 4a. Front view of the dentigerous "premaxillary" bone. Magnified.  
 Fig. 4b. The upper end of the pectoral arch of this specimen.  
 Fig. 5. A pectoral fin of a *Macropoma Mantellii*. In the British Museum (No. 4,258).  
 Fig. 6. The head of a *Macropoma Mantellii*. Figured by Prof. Agassiz, l.c. Fig. 3. In the British Museum (No. 4,252).





*Calacanthus lepturus* (Agassiz)

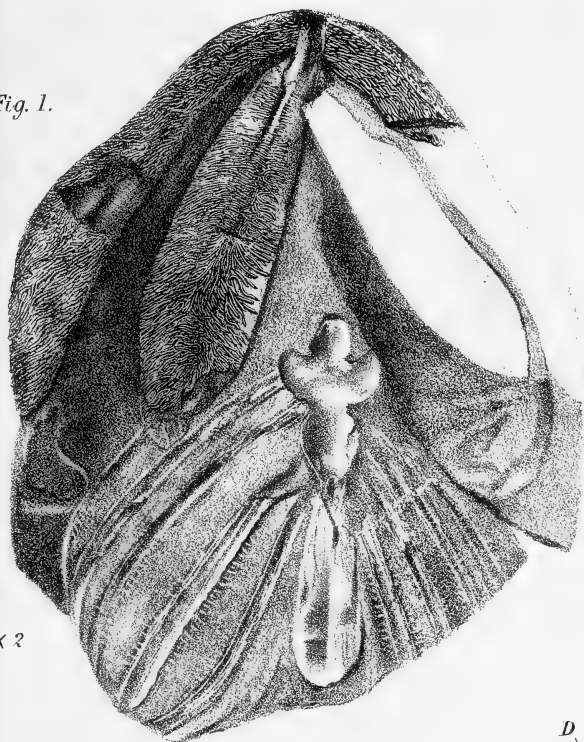




*Cœlacanthus lepturus* (Agassiz)



Fig. 1.



X 2

Fig. 3.

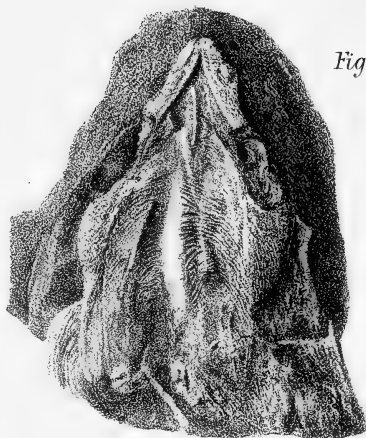


Fig. 4.

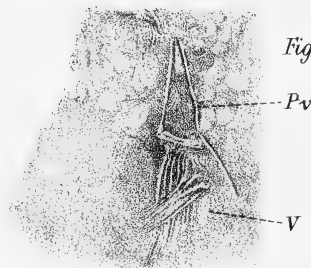
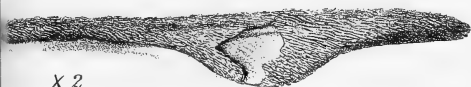


Fig. 2.



X 2

Fig. 5.

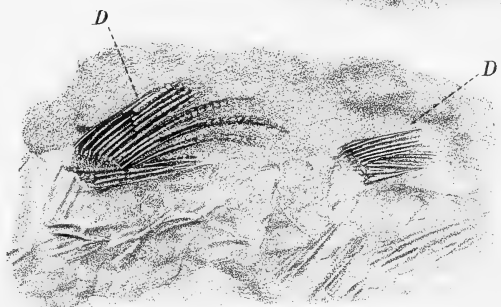
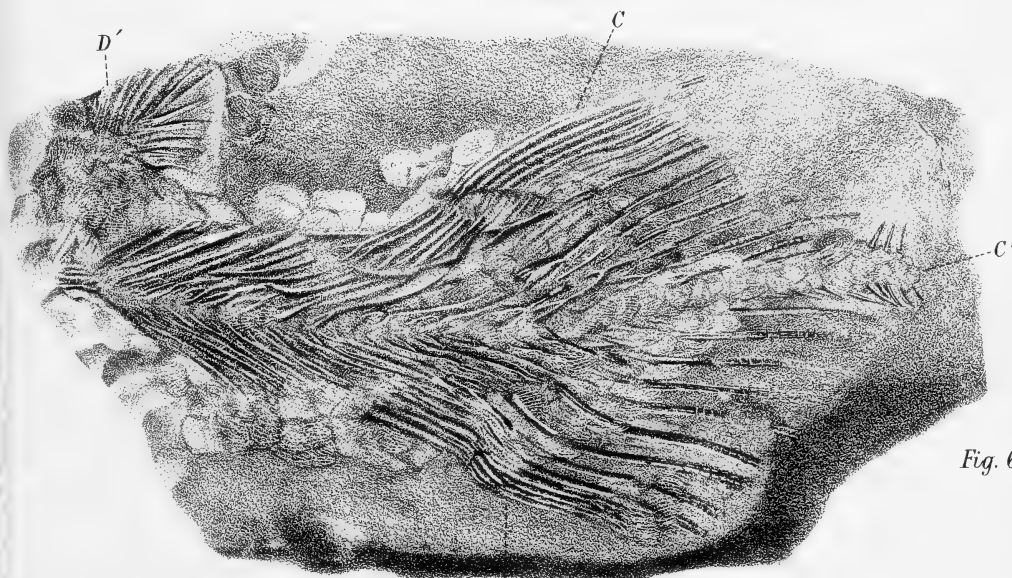


Fig. 6.



X 1½

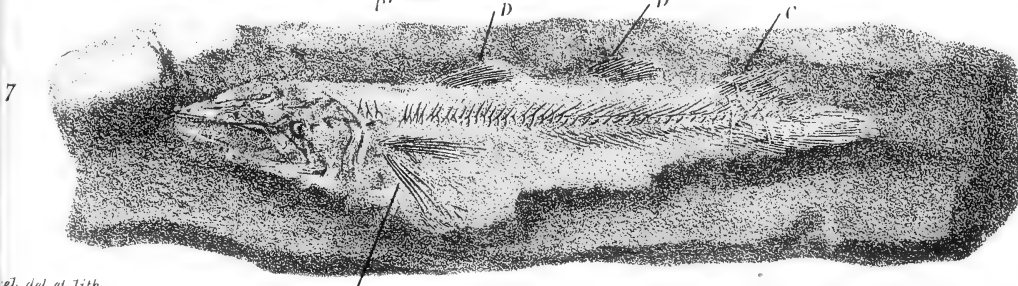
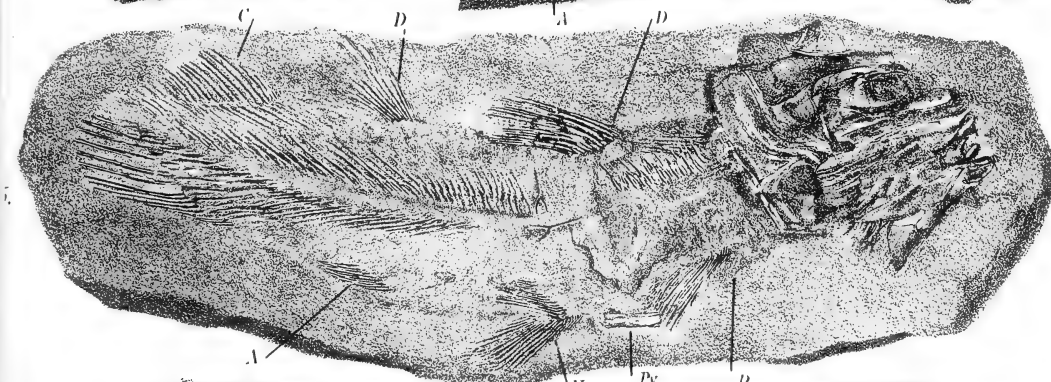
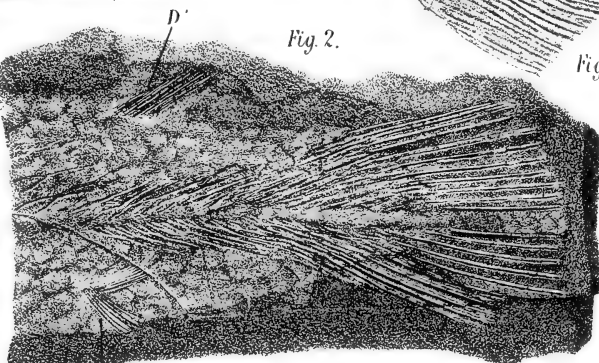
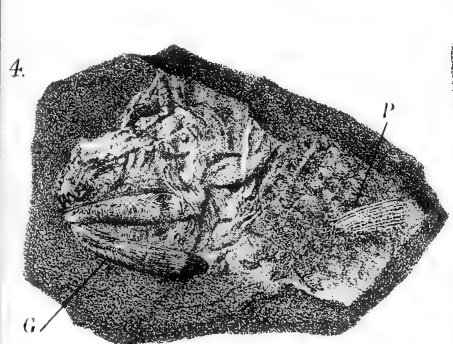
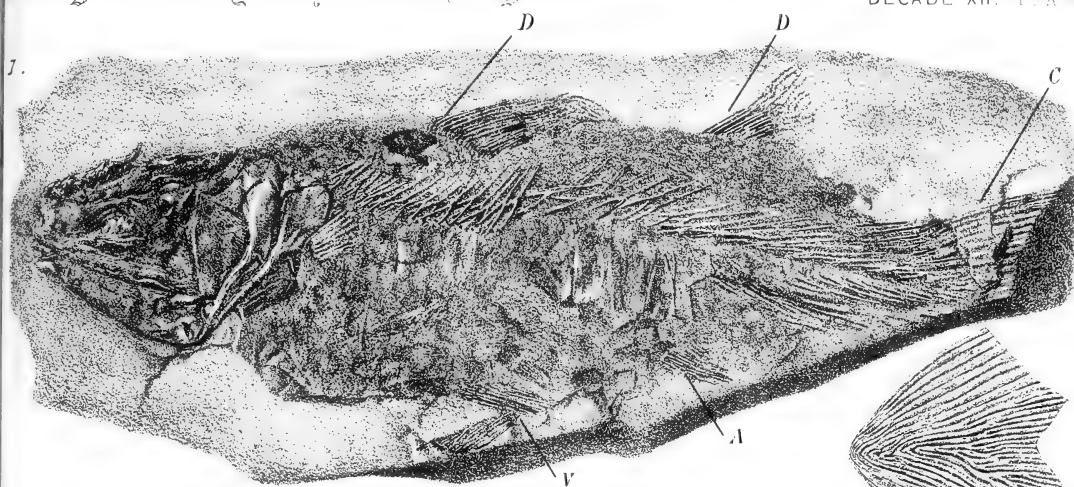
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Day & Son (Limited) Lithrs







del el lith.

Day & Son (Limited) Lith.

*Cœlacanthus elegans* (Newberry) Fig<sup>s</sup> 1-4.  
*Cœlacanthus caudalis* (Egerton.) Fig. 5.  
*Cœlacanthus elongatus* (Huxley.) Fig<sup>s</sup> 6-7.





## PLATE VIII.

The skull of a *Macropoma Mantellii*. In the collection of the Earl of Enniskillen.

- Fig. 1. A view of the right side ; Fig. 2, of the left side ; Fig. 4, from behind.  
 Fig. 3. The under surface, so far as the matrix allows it to be seen.

## PLATE XI.

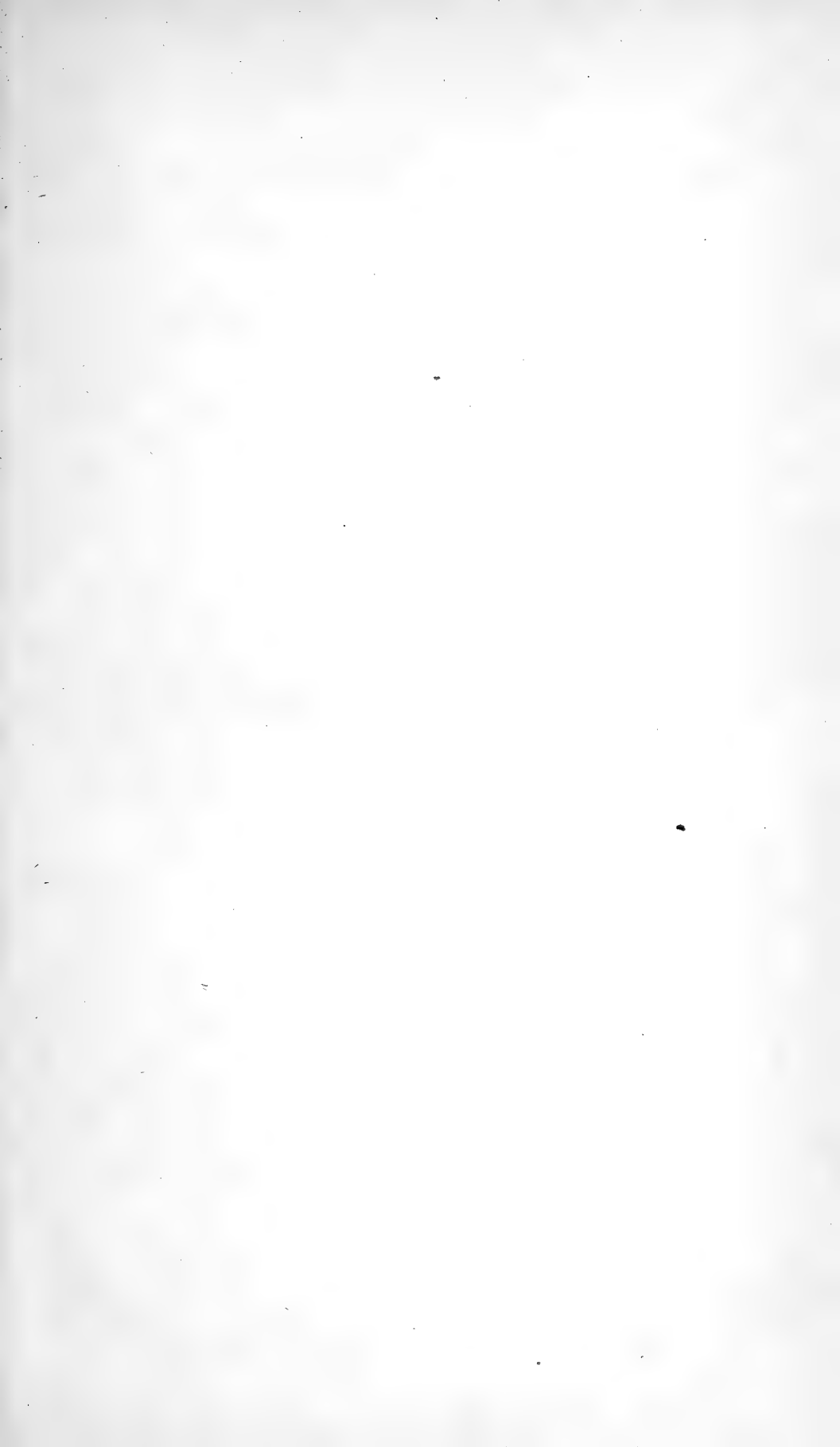
The body of *Macropoma substriolatum*, with a single scale, magnified. In the Woodwardian Museum, Cambridge.

## PLATE X.

The head of the same specimen from above (Fig. 1), the sides (Figs. 2 and 3), and below (Fig. 4). One half the size of nature. In the Woodwardian Museum, Cambridge.

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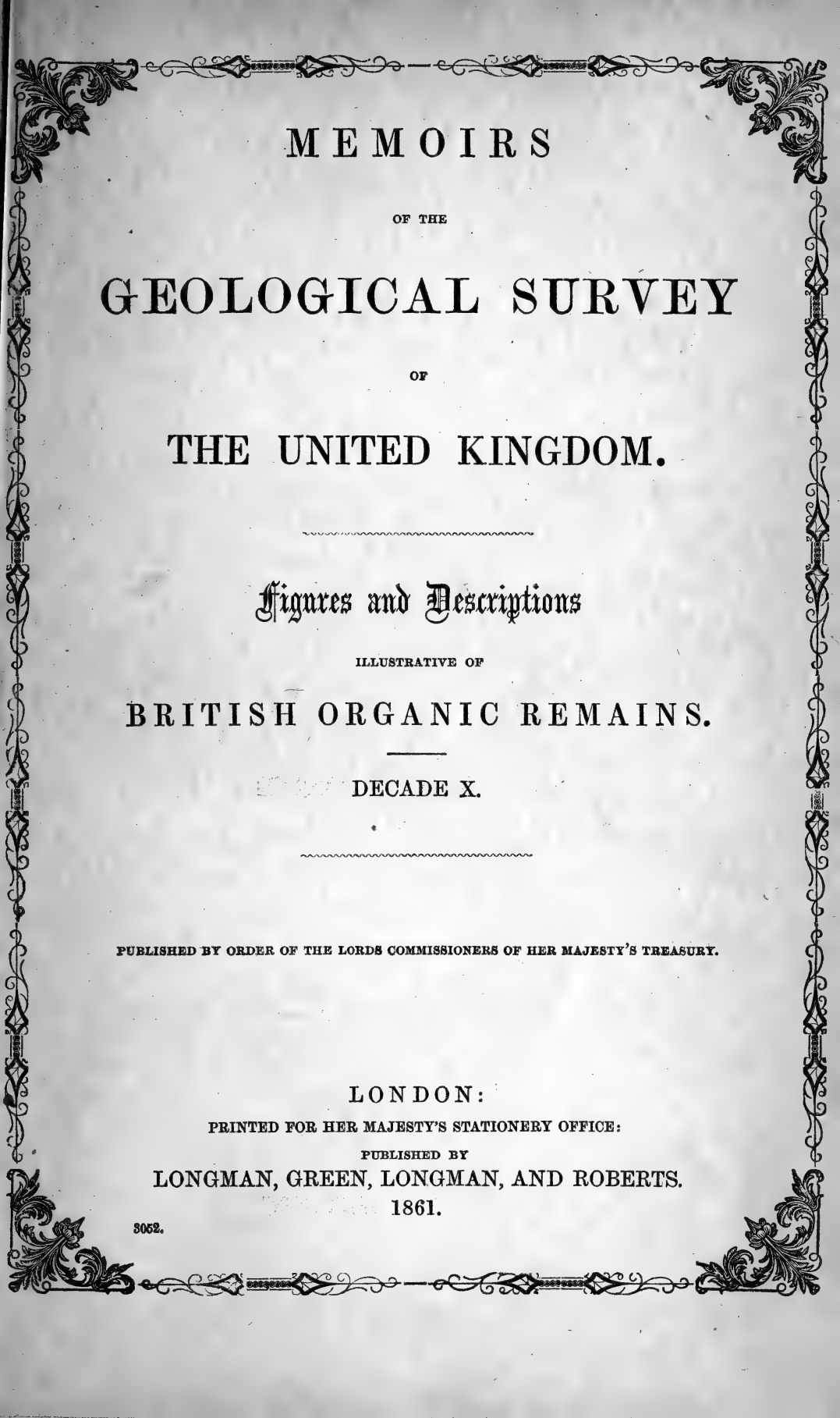
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NATURALIST TO THE GEOLOGICAL SURVEY OF GREAT BRITAIN.

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- 61 SW. Part of Shropshire.
- 61 SE. Part of Shropshire.
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- 74 NW. Part of Denbigh, Merioneth, and Caernarvon.
- 74 NE. Part of Denbigh, Flint, Shropshire, and Merioneth.
- 74 SW. Part of Montgomery, Denbigh, and Merioneth.
- 74 SE. Part of Shropshire, Montgomery, and Denbigh.
- 75 NW. Part of Caernarvon.
- 75 NE. Part of Caernarvon, Merioneth, and Denbigh.
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- 78 SW. S. of Holyhead Island and of Anglesea.
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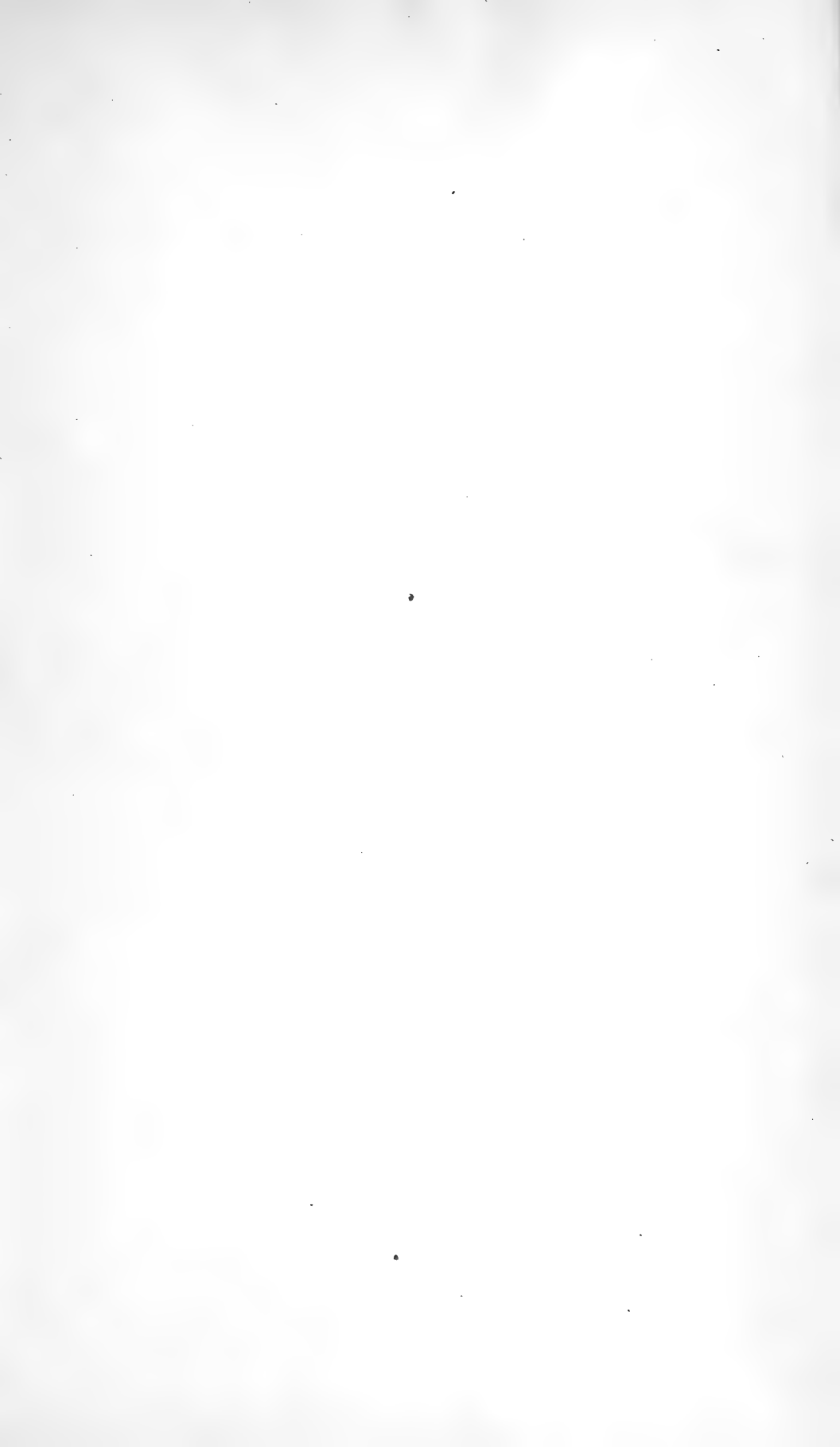
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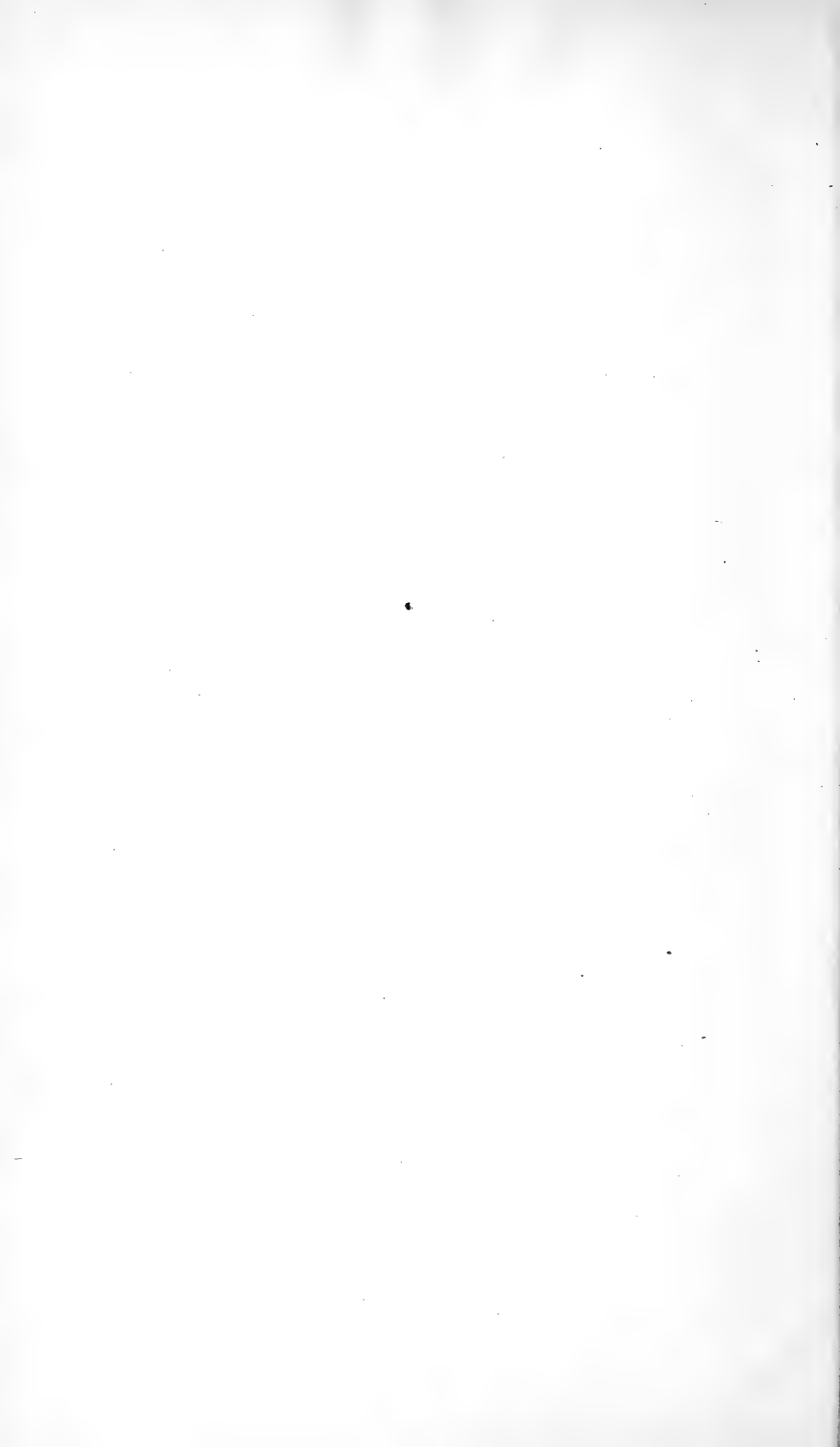
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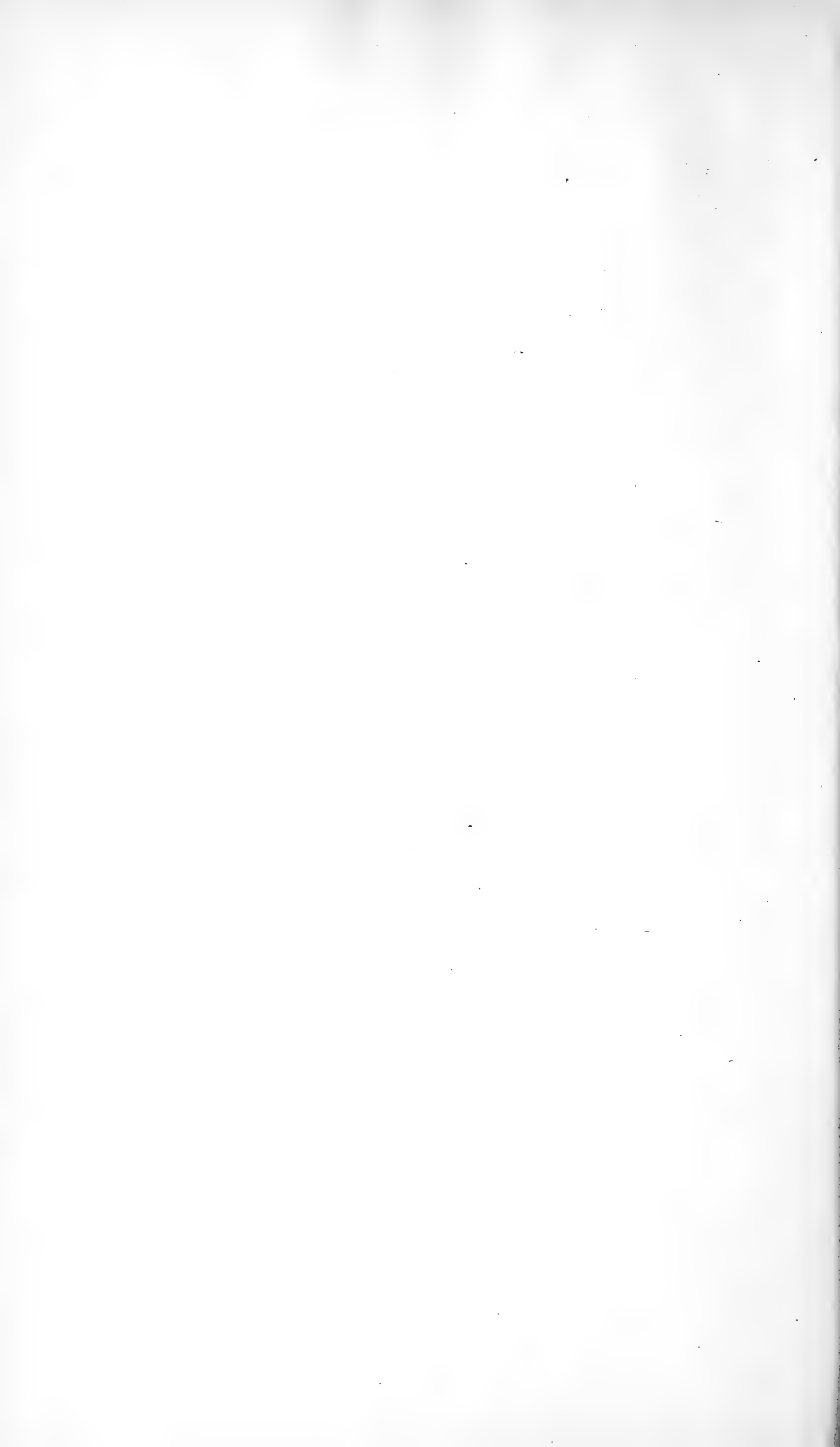
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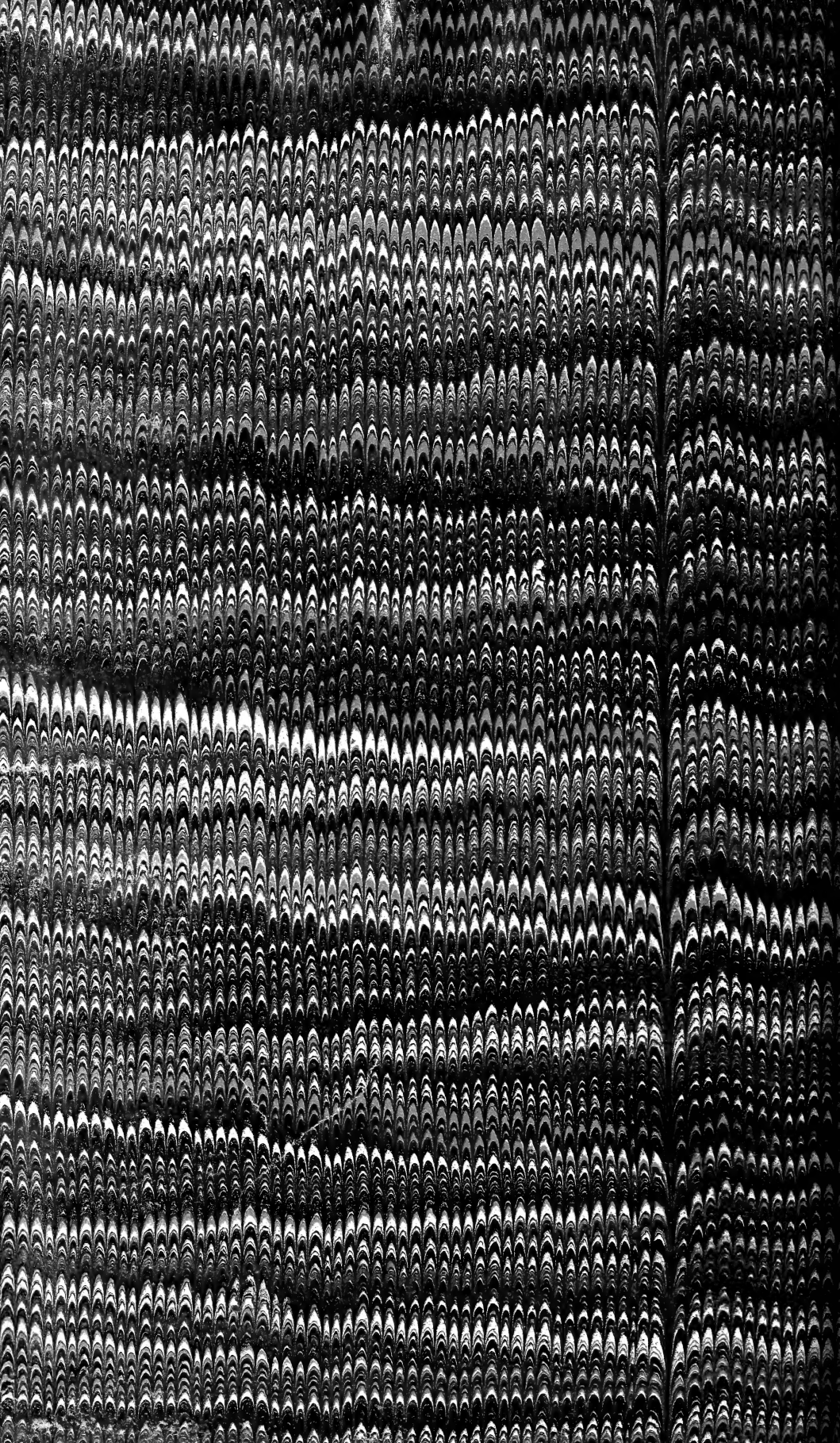


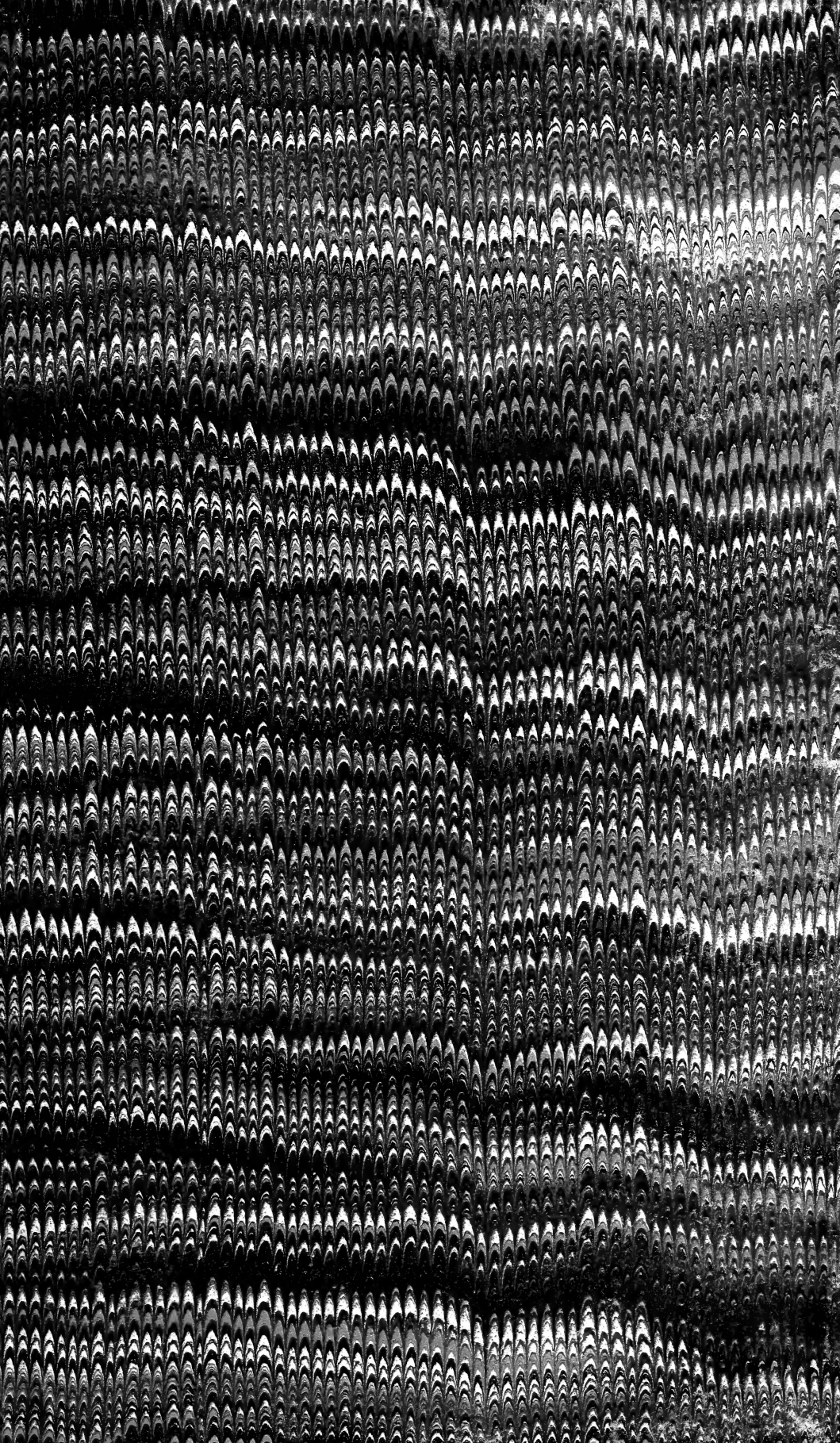












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