



MEMOIRS
OF THE
GEOLOGICAL SURVEY
OF
THE UNITED KINGDOM.

ERRATUM.

DECADE VI. PLATE VI.

For HISTIONOPUS BREVICEPS *read* OPHIOPSIS BREVICEPS.

LONDON: PRINTED BY FVRE AND SPOTTISWOODE, HER MAJESTY'S PRINTERS.

BRITISH FOSSILS.

DECADE THE SIXTH.

THIS the Sixth Decade of representations of British Fossils is devoted to the illustration of some new genera and species of extinct fishes.

The comparative rarity of these fossils renders it impossible to conform to the plan adopted in the preceding Decades of grouping the subjects either according to natural relations or stratigraphical position. The same cause precludes also the possibility of selecting from the collections of the Geological Survey a sufficient number of novelties to complete a Decade.

In accordance, nevertheless, with the request of the Director General, that I would undertake the production of an Ichthyological Decade, I have accomplished the task by selecting subjects from my own cabinet and elsewhere, either entirely new, or little known, none of which have hitherto been figured.

Of these the most interesting is the unique chalk ichthyolite in the collection of the British Museum, described in the last article. The other descriptions comprise a new *Palæoniscus*, from the coal-measures; new species of the genera *Lepidotus*, *Pholidophorus*, *Ptycholepis*, and *Leptolepis*, from the Oxford clay and lias formations; an *Ophiopsis*, from the Purbeck strata, near Tisbury; and a detailed account of a *Chimæroid* fish, *Elasmodus Hunteri*, from the London clay.

The curious structural details of the latter specimens are beautifully delineated in the first copper-plate. The same process of

[VI.]

b

BRITISH FOSSILS.

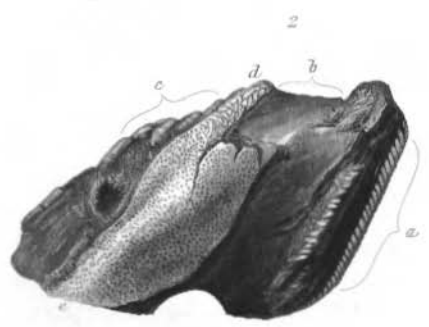
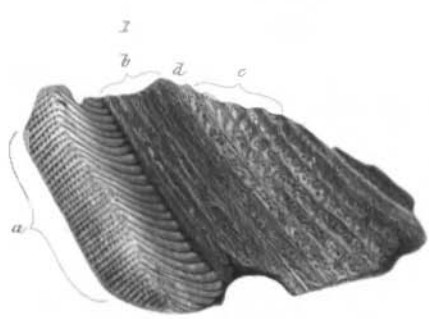
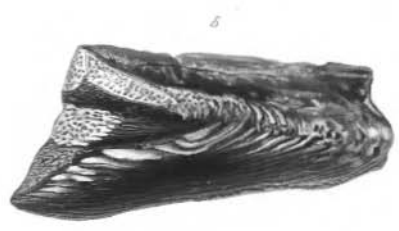
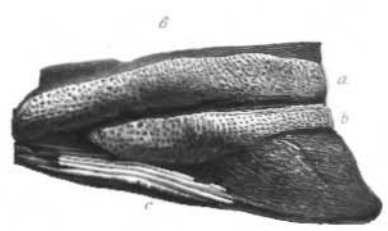
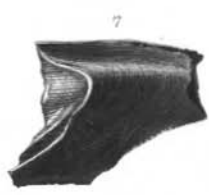
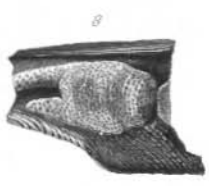
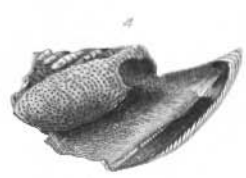
illustration was attempted for the other plates, but the time and labour requisite to produce satisfactory results proved to be so great, that, after the completion of one plate, No. 3 of the Decade, it was considered advisable to have recourse to lithography for the the remainder.

These lithographs have been so beautifully drawn by Mr. Dinkel, that I trust the result of the experiment may be considered sufficiently satisfactory to warrant the employment of this style of illustration in any subsequent Decades devoted to this branch of British Palæontology.

P. DE M. GREY EGERTON.

April 8, 1852.

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ELASMODUS HUNTERI — Egerton.

BRITISH FOSSILS.

DECADE VI. PLATE I.

ELASMODUS HUNTERI.

[Genus ELASMODUS (ἔλασμα, a plate, and δδὸς, a tooth). EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Sub-class Elasmobranchii. BONAPARTE. Order Holocephali. MÜLLER. Family Edaphodontidæ. OWEN.) Lower maxillaries having one tritor on each structure composite, partly of bone, partly of laminated dentine; upper maxillaries bony, intersected by a scroll of laminated dentine forming the outer margins, and a double tritoral tooth on each; premaxillaries composed wholly of laminated dentine.]

SYNONYMS.—*Chimæra Hunteri*, OWEN, *Odontography*, (1840-45), p. 66
Elasmodus Hunteri, EGERTON, *Proceedings of Geol. Soc.*, 1843.

Description.—The dental apparatus of *Elasmodus* is so complicated in its structure, that it is a task of some difficulty to communicate to the reader an exact idea of its many peculiarities. However adroitly this may be accomplished, an inspection of the clear and faithful representations given in the plate will convey a more accurate notion of these curious fossils than any verbal description. The arrangement of the several tissues constituting the lower jaw is as follows:—The anterior portion, comprising nearly one third (figs. 1, 2, *a.*), is composed of a series of laminæ of coarse dentine, superimposed on one another in the following manner. At the symphysis the plates incline downwards and outwards, while on the external front they maintain an horizontal direction for one half their extent, and then slope downwards and backwards to their termination. These are succeeded by a vertical band of coarse fibrous bone (figs. 1, 2, *b.*) occupying the middle third of the jaw. The posterior third (figs. 1, 2, *c.*) has its outer wall composed of a series of vertical columns of laminated dentine, the points of which give to this part of the cutting edge a notched and irregular outline as in the recent *Chimæra monstrosa*. Between this columnar portion and the bony band a thin line of dentine (figs. 1, 2, *d.*) occurs, formed by the continuation of the inner edge of the large triturating tubercle, which traverses the entire substance of the bone. The tubercle itself is composed of dentine, and occupies a considerable part of the

internal surface of the jaw, and extends from the crown to the base (fig. 2, *c*.) In structure it closely resembles the analogous tritores in the genus *Edaphodon*. Both the outer and inner surfaces of the jaw, with the exception of this dentinal plate, were invested with a layer of harder material, as in the genus *Ischyodus*. The remarkable laminated structure, which suggested the generic name, obtains in the upper as well as in the lower jaw. As in the other *Chimæroids*, *Elasmodus* was furnished with two upper maxillary bones, and two premaxillaries. The former were provided with three triturating tubercles (fig. 6, *a, b, c*.) as in *Edaphodon*; but, unlike those of the latter genus, the dentine of which they are composed is confluent, being rolled round, like a scroll, in the substance of the bone; one edge forming the margin of the tooth, the other buried deep in its centre. In the young *Elasmodus* (figs. 7, 8.) the two principal tubercles were united at their bases. The premaxillaries (figs. 9, 10.) are thin, incurved, scalpriform denticles, rounded at the cutting edge. They have the lamelliform structure characteristic of this genus, but correspond with the premaxillaries of the allied genera in the columnar arrangement of the plates, although the columns are not separated by septa of bone.

History.—It was not likely that any organic body, exhibiting peculiarities of structure such as are here detailed, should be passed by unheeded by John Hunter. The specimens figured of the lower maxillaries and the premaxillaries (figs. 1, 2, 9, 10.) are in the Hunterian collection. Shortly after Dr. Buckland's ingenious discovery of the affinities of the fossil *Chimæroids* of the oolitic and cretaceous formations, these specimens attracted the notice of Professor Owen, who recognised their true character, and described them under the name of *Chimæra Hunteri*.* In the course of my examination of the *Chimæroid* family in 1843, I proposed to eliminate these forms under a separate generic title, an arrangement which the subsequent discovery of the upper maxillaries fully confirms. The latter were found by the late Mr. Dixon at Bracklesham, and fortunately show the peculiarities of the dental arrangement both in the young and the adult individual.

Affinities.—The genus *Elasmodus* approaches nearer to the recent *Chimæra monstrosa* than either *Ischyodus* or *Edaphodon*, in the form and structure of the lower jaw, and the premaxillaries; but in every other respect its nearest affinity is with *Edaphodon*.

Localities.—This species is found in the Eocene formations of the

* Odontography, p. 66.

Isle of Sheppey and Bracklesham bay. The specimens selected for illustration are in the collections of the Royal College of Surgeons, and the late Mr. Dixon of Worthing.

EXPLANATION OF PLATE.

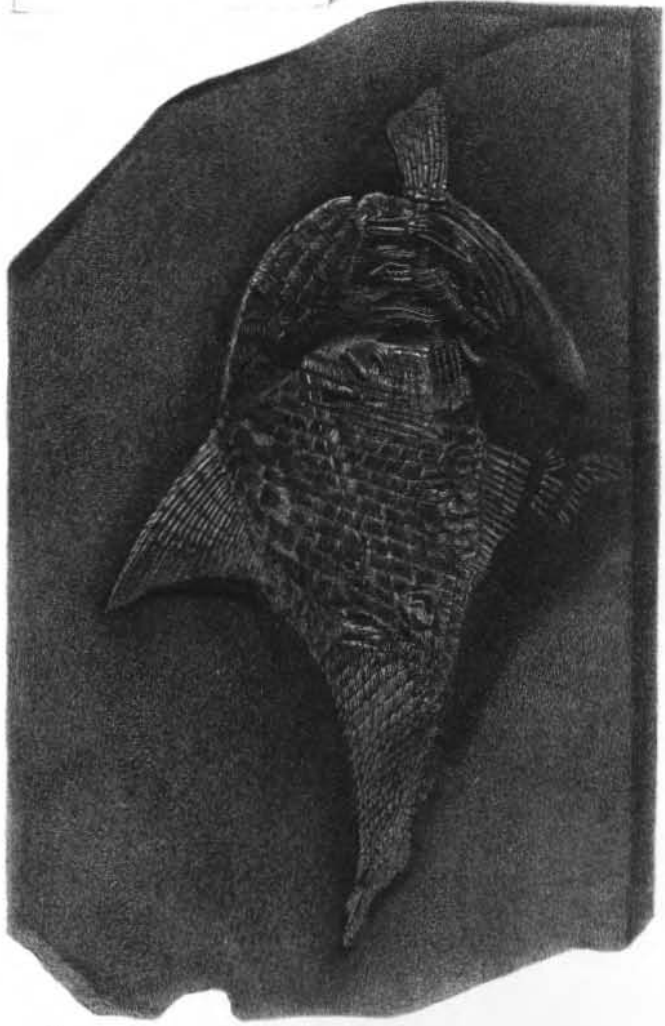
- Fig. 1. Outer view of the lower jaw.
- Fig. 2. Interior view of the same.
- Fig. 3. Outer view of the lower jaw (young).
- Fig. 4. Interior view of the same.
- Fig. 5. Upper view of the superior maxillary plate.
- Fig. 6. Under view of the same.
- Fig. 7. Upper view of the superior maxillary (young).
- Fig. 8. Under view of the same.
- Fig. 9. Outer view of the premaxillary denticle.
- Fig. 10. Interior view of the same.

P. DE M. GREY EGERTON.

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Geological Survey of the United Kingdom

PALÆONISCUS
(Carboniferous)



PALÆONISCUS EGERTONI — Agassiz.

BRITISH FOSSILS.

DECADE VI. PLATE II.

PALÆONISCUS EGERTONI.

[Genus PALÆONISCUS. AGASSIZ. *Palæothrissum*, DE BLAINVILLE. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Lepidostei. Sub-family Lepidostei heteroceri. 1st Group. Body fusiform; dorsal fin single.) Dorsal fin commences opposite the interspace of the ventrals and anal; pectorals and ventrals small; large fulcral scales on the anterior margins of the dorsal, anal, and caudal fins; tail with two lobes; heterocerque.*]

SYNONYMS.—*Palæoniscus Egertoni*, AGASSIZ, Poiss. Foss., vol. ii. p. 302. *Palæoniscus Egertoni*, EGERTON, Quarterly Journal Geol. Soc., 1849, vol. vi. p. 5.

Description.—This species belongs to a limited group of *Palæonisci*, composed of fishes of small size, remarkable for the large and flowing form of the dorsal and anal fins, resembling in this respect the *Amblypteri*, and restricted (as these are) to deposits of the coal-measure period. The species under consideration is one of the smallest of the group, its entire length being not more than $2\frac{1}{2}$ inches. The body is fusiform, its greatest depth being immediately in advance of the dorsal fin, where it measures 7 lines. From this point it contracts gradually anteriorly, but posteriorly the contraction is more rapid to the commencement of the caudal fin. The head is small and slender, occupying less than one fifth of the entire length. The bones are ornamented with strongly-defined sinuous ridges. The characters of the opercular apparatus and the mouth are not shown in the specimen. The pectoral fins are composed of about ten flattened rays. The anterior margin of the fin is provided with a delicate fringe of small rays. The other rays have very few transverse sutures, and do not bifurcate until near their terminations. The dorsal fin commences a little in advance of the opposite insertion of the anal fin. It contains about 25 rays, of which the four or five anterior ones increase in length in succession from before, forming an ornamental border to the fin. The fifth ray is the longest, the

* Poiss. Foss., vol. ii. p. 4.

two succeeding ones are nearly as long, but the diminution in length of the remainder is very rapid. They are all strong, and maintain their size with little variation up to the point where they bifurcate. The transverse sutures are distant, the larger rays having not more than five or six, so long as they continue single. The ventral fins are deficient in the specimen. The anal fin is dislocated, but seems to have been nearly co-extensive with the dorsal fin. The rays are shorter, and the diminution in length of the distal ones more abrupt. The upper lobe of the tail is remarkably long and attenuated, and is invested with small scales to its extremity. The most distinctive character of the species is found in the scales. These are large and solid, of rhomboidal form, and covered with strongly-defined irregular ridges and furrows, the former terminating in sharp cusps on the posterior or free margins. The anterior part of the scale, where it is overlapped by the antecedent scale, is marked with two or more elevated lines parallel to the outline of the border of the scale, being probably lines of increment. These peculiarities are very clearly and faithfully delineated in the magnified view of the scale given in the accompanying plate.

Affinities.—*Palæoniscus Egertoni* is most nearly allied to the species found at Burdie-house, and especially to *Palæoniscus Robisoni*.* It is, however, easily distinguished from this species by the smaller size of the head, the greater depth of the trunk, and the rugous character of the scales. *Palæoniscus monensis*† has not yet been found entire; there is nevertheless sufficient evidence in the detached scales to distinguish it from this species. The ornament of the surface is less prominent, and the lines are parallel to each other, and straight, whereas in *Palæoniscus Egertoni* they are irregular and sinuous. No foreign species has the least resemblance to it.

History.—In 1835,‡ I communicated to the Geological Society of London the discovery of numerous remains of fishes in the coal shale of the Silverdale pits near Newcastle-under-Lyne. They consisted of bones and scales belonging to the genus *Megalichthys*, then recently found by the late Dr. Hibbert Ware, at Burdie-house, and figured in the Transactions of the Royal Society of Edinburgh,§ teeth of *Diplodus gibbosus*, and scales of a small *Palæoniscus*, which were pronounced by Professor Agassiz to indicate a new species of the genus. Shortly afterwards, my brother, the Rev. W. Egerton, discovered in the same bed the pretty little specimen represented in

* Agassiz, Pois. Foss., vol. ii. p. 88. † Quart. Jour. Geol. Soc., 1849, vol. vi. p. 5.

‡ Proc. Geol. Soc., 1835.

§ Vol. xiii. pl. 8 and 11.

the plate, which fully corroborated the accuracy of Professor Agassiz's conclusion, founded upon the isolated scales submitted to his examination. Although the species is recorded in the "Poissons Fossiles," the description of it never appeared, in consequence of the abrupt termination of that work. The great rarity of tolerably perfect specimens from the shale-beds of our coal-measures, and the value of well-marked species in considering the relations of these beds in one district with those in others, render it desirable to record a correct figure and description of this species, although it is not a subject of novelty.

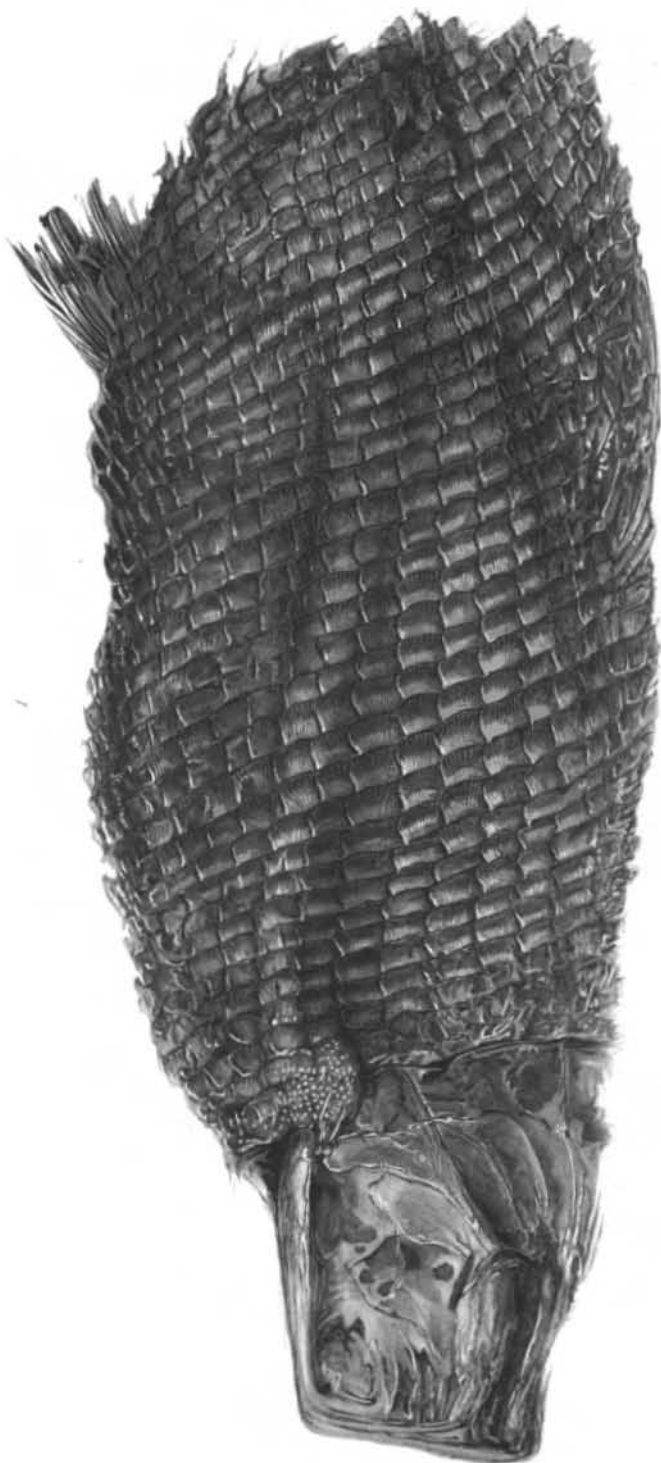
Localities.—Silverdale, near Newcastle-under-Lyne, in a fine, compact, black shale; highly fissile, with a slightly conchoidal fracture. Also in Lancashire and Yorkshire, and in some of the Scotch and Irish coal-fields.

EXPLANATION OF PLATE.

- Fig. 1. *Palæoniscus Egertoni*, natural size.
Fig. 2. Same, magnified twice.
Fig. 3. Scale, magnified ten times.

P. DE M. GREY EGERTON.

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LEPIDOTUS PECTINATUS — *Egerton.*

BRITISH FOSSILS.

DECADE VI. PLATE III.

LEPIDOTUS PECTINATUS.

[Genus *LEPIDOTUS*. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Lepidostei. Sub-family Lepidostei homocerci. 2d Group. Body elongated, more or less fusiform.) Dorsal fin opposite the interval between the ventrals and anal; caudal fin large, with strong fulcral scales on the margins; the base of the upper lobe invested with scales; teeth conical, obtuse; scales rhomboidal, large and thick, invested with a dense layer of ganoine.*]

SYNONYM.—*Lepidotus pectinatus*, EGERTON, Proceedings of Geol. Soc., 1843, p. 184.

Description.—The genus *Lepidotus* is one of the most interesting in the *Ganoid* order of fishes, in a zoological point of view, as presenting the best subjects for the examination of the structure and development of the singular tegumentary investment upon which Agassiz established the order, and in other respects as containing numerous species, easily recognized, frequently in a good state of preservation, and always characteristic of the age of the strata in which they occur. Agassiz has described sixteen species in the “Poissons Fossiles,” and several new ones have been discovered since the publication of his work. I know few fossils more beautiful than the *Lepidotus*. The large size of some of the species, the rotundity of contour (so frequently preserved by the rigidity of their dermal encasement when every vestige of the endo-skeleton and its associated organs has disappeared to be replaced by indurated mud), the ornamental sculpturing of the cranial bones, and above all, the regularity and brilliancy of the scales, and the delicate tracery so frequently engraved on the glistening enamel, all combine to render the remains of this genus most attractive, and little liable to be overlooked by the most careless observer. The species range from the chalk to the lias inclusive; one only occurs in the cretaceous series, four in the wealden, six or seven in the oolites, and eight in the lias. From the latter formation at Whitby the subject of this article is derived. It measured, as far as can be calculated from an imperfect specimen,

* Agassiz, Poiss. Foss., vol. ii. p. 233.

probably not more than 9 inches in length by $2\frac{3}{4}$ inches in depth, and bears undoubted marks of mature age in the successive lines of growth engraven on the surfaces of the scales. The head is imperfect, but from what remains it seems to have been longer and narrower than in *Lepidotus minor*. A mutilated dorsal and ventral fin are the only natatory organs preserved. The former is smaller and less powerfully constructed than is usual in the *Lepidoti*; the fulcral scales are shorter and narrower, and the fin rays more arched than in *Lepidotus minor*; the latter is situate rather nearer the head than in that species. The trunk is more slender than in any of the genus, and affords an unmistakeable characteristic of the species; but in addition to this we find in the scales such clear specific indications, that they could be recognized in the most imperfect and fragmentary condition. Those on the anterior part of the body are larger in the vertical than in the longitudinal direction; about the flanks these dimensions are nearly equal; while in the vicinity of the tail the longitudinal diameter is the greatest. They have the upper border convex, and the lower one concave on the greater portion of the body, which gives a remarkable undulating character to the cephalo-caudal series. The dorso-ventral series are more oblique than in *Lepidotus minor*, and the joinings of the scales in the succeeding columns fall nearer the centres of the scales of each antecedent series. They contain about sixteen scales in each. These are characterized by delicate radiating striations which give a pectinated edge to the posterior margin of the scale. The striations disappear in the caudal region, and the scales are smooth with entire edges. In the young fish the striato-pectinate character seems to have existed to a greater extent than in the adult, as on some of the caudal series zigzag lines are still apparent, which at one period must have been the free margins of the scales.

Affinities.—In the proportion and character of the scales this species approaches the genus *Semionotus*.

History.—An unique specimen in the collection of the Earl of Enniskillen.

Locality.—Lias of Whitby, in Yorkshire.

EXPLANATION OF PLATE.

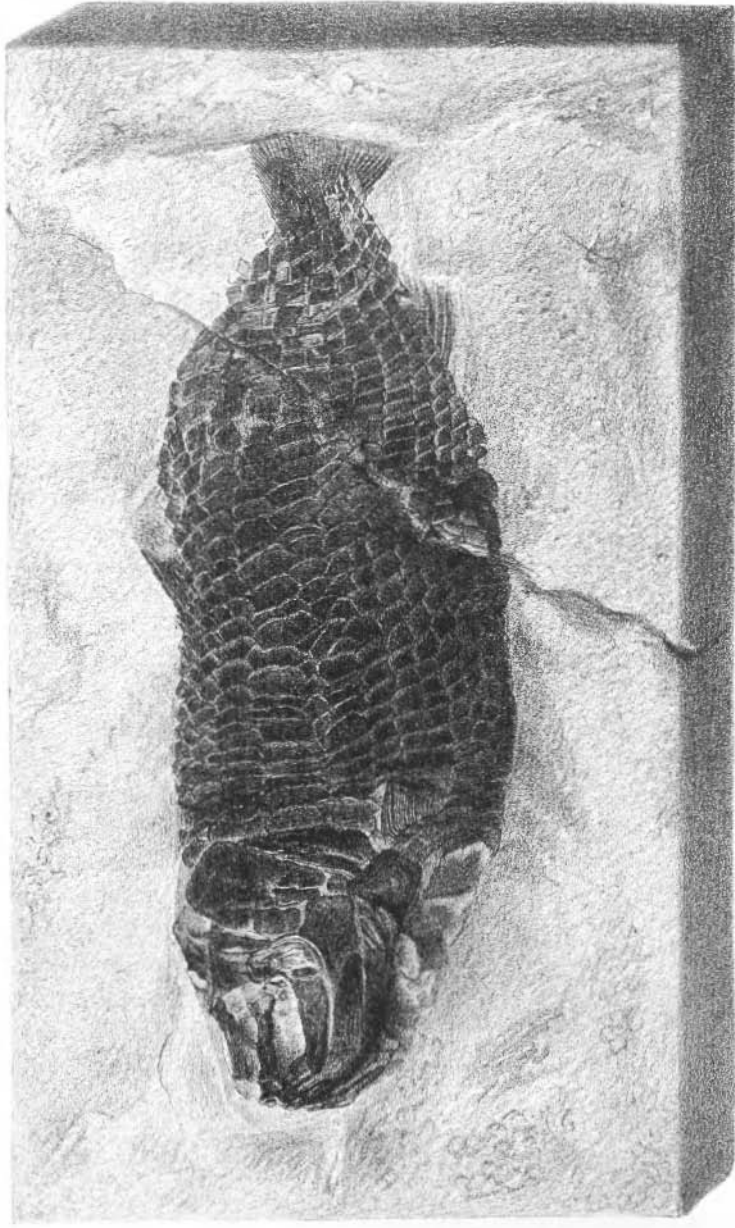
Fig. 1. *Lepidotus pectinatus*, size of nature.

Fig. 2. Scales, magnified.

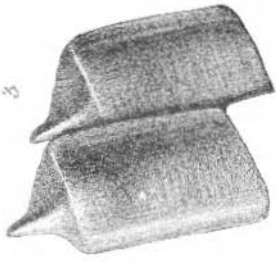
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PHOLIDOPHORUS PACHYSOMUS.—*Egerton.*

BRITISH FOSSILS.

DECADE VI. PLATE IV.

PHOLIDOPHORUS PACHYSOMUS.

[Genus PHOLIDOPHORUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonialepidoti. 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 pachysomus, EGERTON.

Description.—This species is easily detected by its stumpy and inelegant proportions, which contrast strongly with the graceful forms of the associated *Pholidophori*. The head bears the proportion of 2 to 7, as compared with the length of the fish to the insertion of the caudal fin, whereas this measurement in *Pholidophorus Bechei* is as 1 to 4. The depth of the body at the dorsal fin is equal to one half of the length from the scapular arch to the tail. This unusual proportion gives an oval outline to the body, very distinct from the fusiform shape of the generality of the species. As compared with *Pholidophorus Bechei* the lower jaw is shorter and stronger, the orbit larger, and the surface of the opercular bones less uneven. The rays composing the pectoral fin are more slender. The space from the occiput to the insertion of the dorsal fin is much less, as is likewise the distance between the ventral fins and the tail. The other characters of the natatory organs correspond pretty nearly with those of that species. The scales are of large size, and perfectly smooth. The series, counting along the lateral line from the scapular arch to the tail, contain only 30 scales, being 10 less than are found in *Pholidophorus Bechei*. Those in the centre of the flanks are the largest. The posterior edges are curvilinear, and slope rather obliquely backwards and downwards; in some specimens they are translucent, in consequence of the thin plate of ganoine projecting beyond the opaque material

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

of the body of the scale. The articulating processes of the scales are remarkable for their width and strength (Fig. 3.)

Affinities.—This species most resembles *Pholidophorus Bechei*.

History.—The description is taken from two specimens in my possession. Lord Enniskillen has also a specimen of this species.

Locality.—Found in the lias at Lyme Regis.

EXPLANATION OF PLATE.

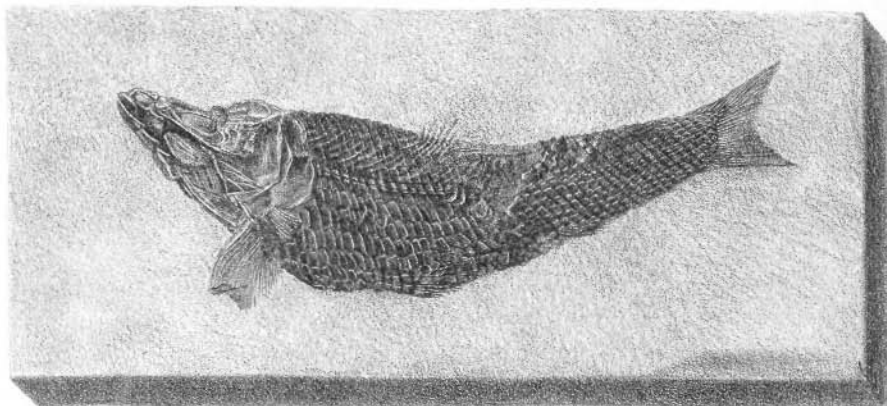
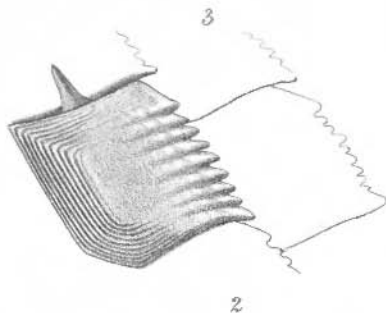
Fig. 1. The fish, natural size.

Fig. 2. The caudal vertebræ.

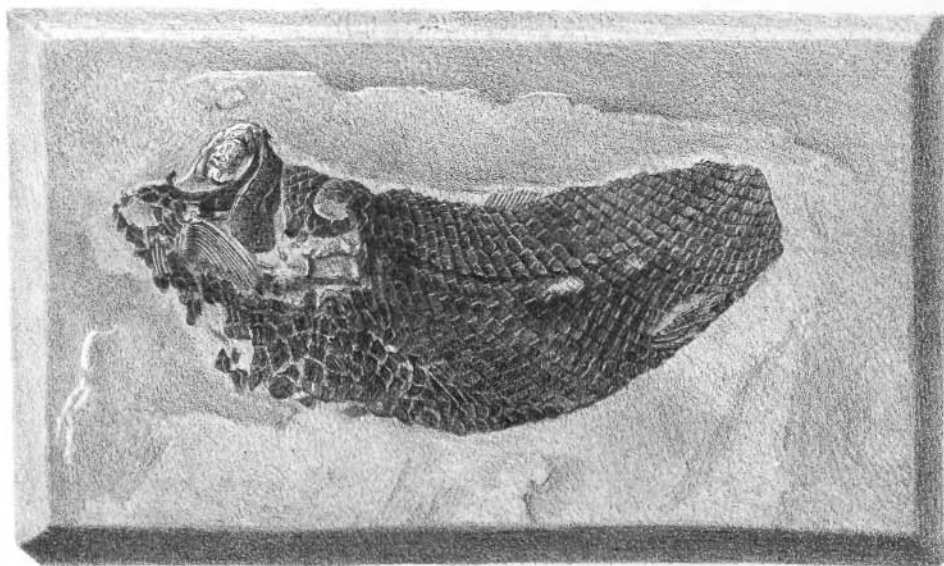
Fig. 3. Scales, magnified.

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PHOLIDOPHORUS CRENULATUS. *Egerton.*

BRITISH FOSSILS.

DECADE VI. PLATE V.

PHOLIDOPHORUS CRENULATUS.

[Genus PHOLIDOPHIORUS. 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 crenulatus*, EGERTON, Proceedings of Geol. Soc. 1843, p. 184.

Description.—This is a rare but well-marked species of *Pholidophorus* belonging to the group of which *Pholidophorus Bechei* may be considered the type. In form and proportions it resembles *Pholidophorus latiusculus*, but the characters of the scales are wholly dissimilar. Of the *Pholidophori* of the lias, described by Agassiz, one only, namely *P. limbatus*, has serrated scales. This structure obtains also in *Pholidophorus crenulatus*, under description, but it is the only feature common to the two species. The head is either crushed or wanting in the only specimens I have seen. It seems to have been smaller in proportion to the entire length of the fish than in *P. Bechei*, *P. onychius*, and *P. limbatus*. The coracoid bone is traversed obliquely along its anterior curvature with rounded plaits. The pectoral fins are large, composed of about 22 rays, slender, and dichotomous in their distal portions. The anal fin is small. The caudal fin contains from 28 to 30 rays, with short articulations. The lower lobe is considerably larger than the upper one. The base of the upper lobe is invested with scales, and its upper margin protected by a series of strong imbricated fulcral scales; these increase in length as they succeed each other, until they almost rival the true marginal rays of the lower lobe. The scales present two very distinctive characters. The anterior portion or base of the scale is marked by a series of parallel, vertical ridges, extending backwards as far as the articulating pro-

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

cess. These are covered by the antecedent scales, and mark the periodical increment. I have failed to find these evidences retained in any other species of this genus, although they are permanent in *Palæoniscus*, and some other genera. The exposed portions of the scales are traversed by alternate longitudinal plaits and striations, radiating at various angles, and increasing in size as they approach the free margins of the scales. These are slightly thickened, and distinctly serrated. The number of teeth carried by each scale is dependent on the number of striæ, and these decrease in the more distant parts of the body. The ventral scales are characterized by the coarseness of the cusps, and the paucity of the striæ. The dorsal and ventral fins are as yet unknown; judging from the fragments preserved in the specimens figured, they probably resembled these organs in the other species from the lias.

History.—The specimens from which the description is taken are in my own cabinet.

Locality.—Lias of Lyme Regis.

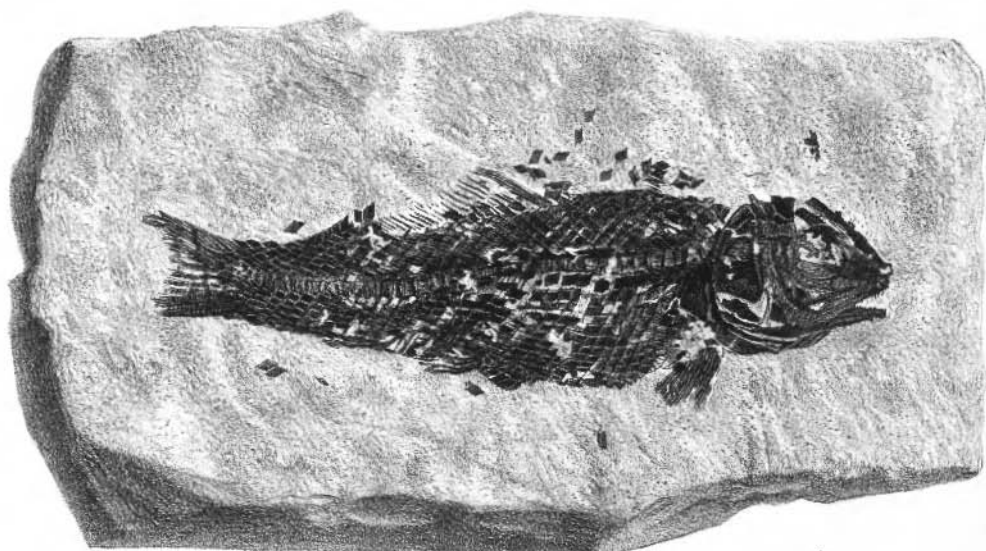
EXPLANATION OF PLATE.

- Fig. 1. The fish, natural size.
Fig. 2. Same (young).
Fig. 3. Scales, magnified.

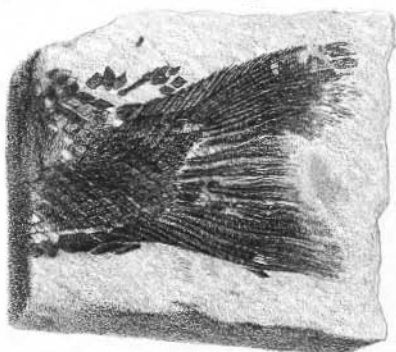
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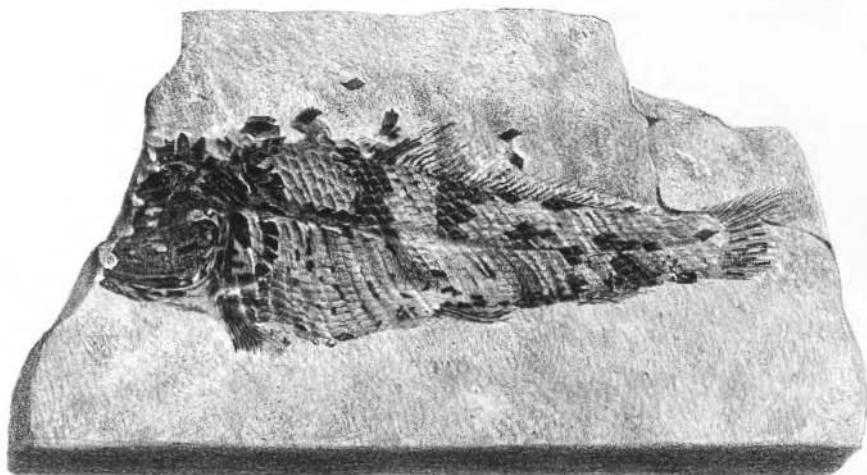
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2



HISTIONOTUS BREVICEPS. — Egerton.

BRITISH FOSSILS.

DECADE VI. PLATE VI.

OPHIOPSIS BREVICEPS.

[Genus OPHIOPSIS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Lepidostei. Sub-family Lepidostei homocerei. 2d Group. Body elongated, more or less fusiform.) Scales uniform in size; caudal fin slightly forked, the upper lobe invested with scales on the superior margin; pectoral fins long and large; dorsal fin much elongated, and slightly raised; ventral fins opposite the centre of the dorsal fin; head small; opercular apparatus strong and broad.]*

Ophiopsis breviceps, EGERTON.

Generic Description.—The genus *Ophiopsis*, as originally defined by Agassiz (Poissons Fossiles, vol. ii. p. 289), was limited to a small number of fishes characterized by an extended dorsal fin, smooth, uniform scales, and a prolonged upper lobe of the dorsal fin. Subsequently, as we find in the “Additions et corrections,” vol. ii. part 2, p. 289, a fish named *Ophiopsis Münsteri* was admitted into the genus, having serrated scales and other features approximating it to the *Pholidophori*. In consequence of this extension of the generic attributes, the boundary line between *Ophiopsis* and *Pholidophorus* becomes very indistinct; for, while on the one hand we have the elongated form and extended dorsal fin of the typical *Ophiopsis procerus* occurring in *Pholidophorus FleSheri*, on the other we have the small head and serrated scales characteristic of several species of *Pholidophorus*, cited as distinctive features of *Ophiopsis Münsteri*. We find also the uniformity of scales and unequal tail of *Ophiopsis* represented in *Pholidophorus latimanus*, *tenuiserratus*, *longiserratus*, and other species of the Oolitic epoch. This is not a fitting opportunity for entering on the general question of the propriety of rearranging the various forms now included in the genus *Pholidophorus*; as bearing, however, on the subject of the present article, I may hazard the opinion that if any reliance is to be placed on the generic characters assigned by Agassiz to *Ophiopsis*, it must be on the distinctive features of the dorsal fin; and if so, all the *Pholidophori* having extended dorsal fins must be removed from the latter

* Agassiz, Poiss. Foss., vol. ii. part 2, p. 289.

to the former genus. In tracing the gradation from the narrow elongated form of the typical *Ophiopsides* to the shorter and thicker proportions of the *Pholidophori*, the little fish described in the following paragraphs, occupies the extreme limit between the two genera; the transitional form of *Ophiopsis penicillatus* completing the series of that genus. It must, nevertheless, be considered a true *Ophiopsis*, since the characters of the dorsal fin and vertebral column are in strict accordance with that genus, and are of greater value than the more trivial features in which it resembles some species of *Pholidophorus*.

Description.—*Ophiopsis breviceps* is a small fusiform fish, measuring 4 inches in length by 1 in depth. The head occupies only one fourth of the entire length. The vertebral column extends in a direct line from the head to the commencement of the caudal fin, without any curvature in the thoracic and abdominal regions. The bones of the head and gill-covers are ornamented with a pattern rather coarser than is usual in so small a fish. The mouth is large, and well furnished with small, conical, sharp teeth. The pectoral fins resemble those of the *Pholidophori*. The ventral and anal fins are small, and approximate to each other. The dorsal fin commences in advance of the ventral fins, and extends beyond the insertion of the anal fin. It contains nearly forty rays. The upper lobe of the tail is larger than the lower one, and is invested with scales for some distance, giving a heterocerque character to the organ. The scales are small and rhomboidal. The upper margins are concave, the lower ones convex. The enamel appears thicker on the margins of the scales, causing a slight depression of the central area. The posterior edges are strongly serrated over the whole body.

Affinities.—The generic affinities have been already alluded to. The species is very distinct from all with which I am acquainted.

Locality.—Lowest beds of the Lower Purbecks in Wockly, or Oakleigh quarry, near Tisbury.

History.—The figures and description are taken from the specimens in the collection of the Museum of Practical Geology, the only ones I have seen of this species.

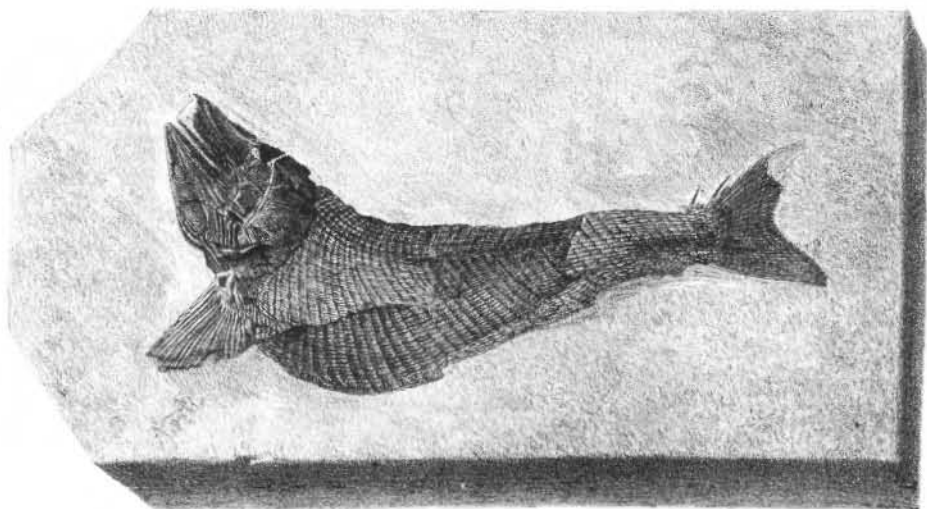
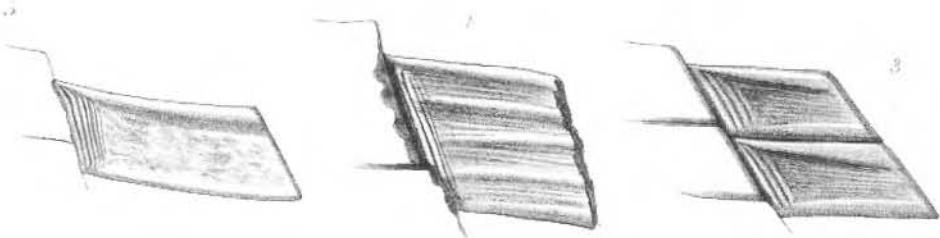
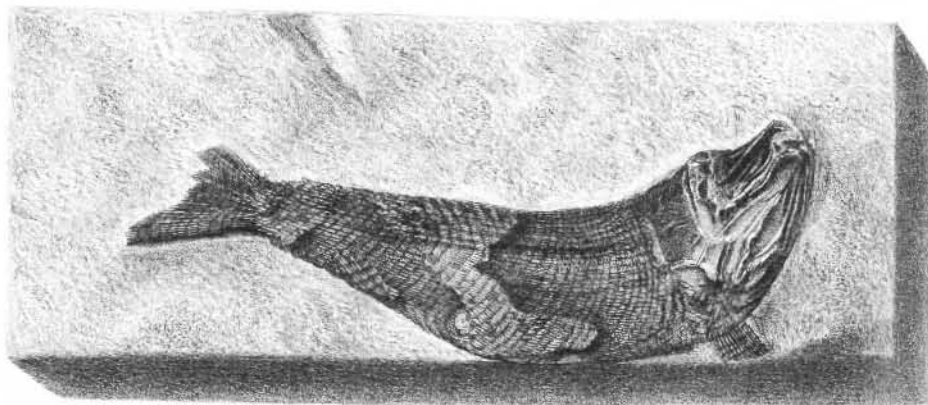
EXPLANATION OF PLATE.

- Fig. 1. 2. The fish, natural size.
 Fig. 3. Scale, magnified.
 Fig. 4. Tail of a larger individual.*

P. DE M. GREY EGERTON.

* This may be *Ophiopsis penicillatus*.—Agassiz, Poiss. Foss., vol. ii. p. 290.

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PTYCHOLEPIS MINOR — *Egerton.*

BRITISH FOSSILS.

DECADE VI. PLATE VII.

PTYCHOLEPIS MINOR.

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

Ptycholepis minor, EGERTON.

Description.—The genus *Ptycholepis* has hitherto been restricted to a single species, *Ptycholepis Bollensis*, remarkable for its occurrence in several widely-separated localities, viz., Whitby in Yorkshire, Lyme Regis in Dorsetshire, and Ohmden, in the kingdom of Wurtemberg. Being in possession of a fine series of specimens from each locality, I am enabled to amend the generic characters formed by Agassiz on imperfect materials. The pectoral fins when perfect are pointed rather than rounded at their extremities, and of moderate size. The dorsal fin is more remote than Agassiz imagined, being situate nearly as far back as in *Eugnathus*, and the anal fin is nearer to the tail than to the ventral fins. A very distinct character obtains in the under surface of the scales, not found in *Eugnathus*, or the allied genera. In these a projecting rib occurs, traversing the middle of each scale, produced to a point at the upper margin, and recessed at the lower, for the reception of the corresponding process of the adjoining scales; but in *Ptycholepis* the under surface is level, and the articulation is effected by an angular process of the upper margin of the scale, adapted to a notch in the lower margin of the succeeding scale. The specimen under description belongs undoubtedly to this genus, although the small size of the fish and its general outline recal at first sight the features of a *Pholidophorus*. The total length of the fish, including the tail, is 4 inches, of which the head occupies one fourth part; the greatest depth is 10 lines; this point occurs immediately behind the gill-covers, from whence the body diminishes gradually to the base of

the tail. The bones of the head are marked with irregular, projecting lines at distant intervals, interspersed with small isolated tubercles. The opercular bones are similarly ornamented, but the intervals between the lines are rather larger. A few scales immediately behind the scapular arch, on the central part of the body, are of large size. These are traversed by five or six longitudinal sinuous furrows, and terminate with a serrated margin. They are succeeded by scales more elongated, and having fewer and more regular furrows, and these on the dorsal, ventral, and anal regions give place to the narrow elongated scales (fig. 5.) peculiar to this genus. All the scales have their bases,—or those parts overlapped by the antecedent scales,—marked by parallel, transverse plicæ, showing the periods of growth. In this character they resemble the scales of *Pholidophorus crenulatus*, and some *Palæonisci*. The pectoral fin is broad at the base, and pointed at the termination. It is composed of about 30 rays. The transverse articulations of the rays are frequent near the base, but very distant in the other portions of the fin. The dorsal, ventral, and anal fins are wanting. The tail is small and elegantly forked. The articulations of the rays are more numerous in the lower than in the upper lobe, but the intervals between them become greater as they recede from the base. In these respects this organ has considerable resemblance to the caudal fin of *Pholidophorus*. The endo-skeleton in this genus was probably entirely cartilaginous, since I have been unable to discover in any specimen the least trace or impression of the spinal column or its appurtenances.

Affinities.—The genus *Ptycholepis* is considered by Agassiz to be most nearly allied to *Eugnathus*. This opinion is founded upon the characters of the scales and teeth. The latter I have not been able to detect in my specimens. In other respects it has considerable resemblance to the *Pholidophori*, and especially to some of the narrow-scaled species of that genus, which I have proposed to remove to the new genus *Histonotus*. These features, together with the absence of a bony endo-skeleton, which is of considerable solidity in *Eugnathus*, lead me to infer that the *Ptycholepides* were altogether more feeble and less predatory than the *Sauroid* genera, with which they are allied.

Locality.—The specimen above described was found in the lias quarries at Barrow-on-Soar, and is the only example of this species I have met with. The two halves are in the possession of Lord Enniskillen and myself.

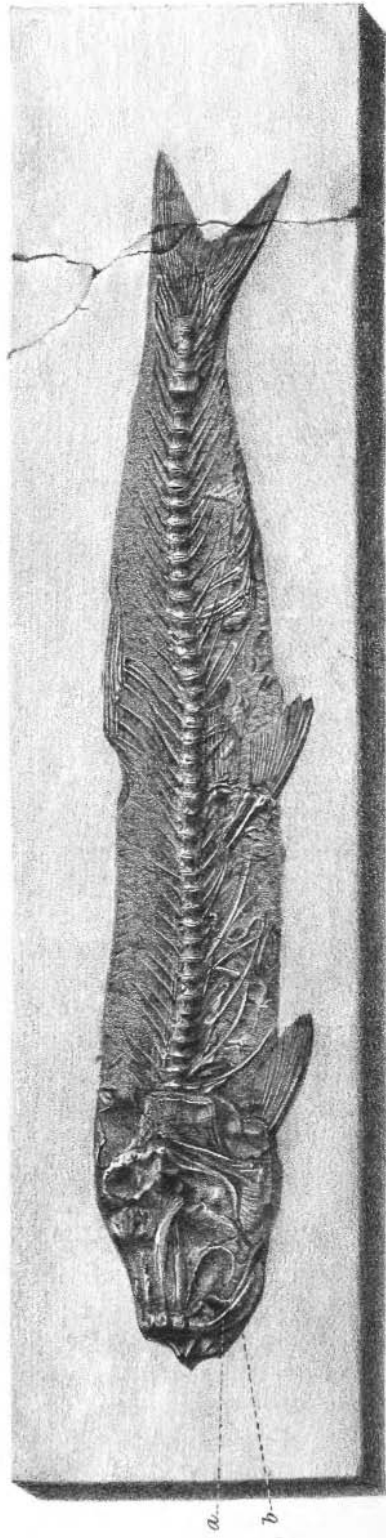
EXPLANATION OF PLATE.

- Fig. 1. Fish, natural size.
Fig. 2. Counterpart of same.
Fig. 3. Scales from the flank.
Fig. 4. Scale near the scapular arch.
Fig. 5. Scale near the tail.

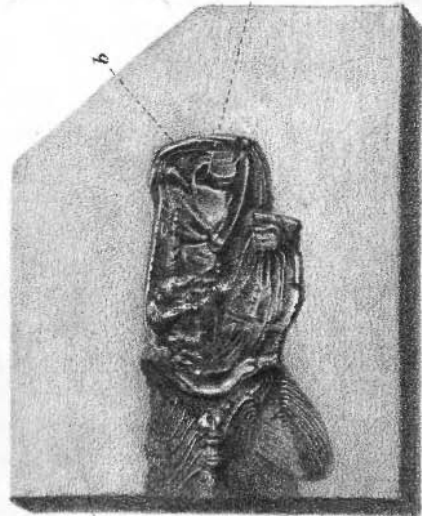
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LEPTOLEPIS MACROPHthalmus. Egerlon.

BRITISH FOSSILS.

DECADE VI. PLATE VIII.

LEPTOLEPIS MACROPHALMUS.

[Genus LEPTOLEPIS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st Group. Tail forked.) Scales very thin and rounded; dorsal fin opposed to the ventrals; operculum broad; sub-operculum large; teeth villiform; lower maxillaries with strong coronoid processes.]

SYNONYM.—*Leptolepis macrophthalmus*, EGERTON, Journal of Geol. Soc., vol. i. p. 231.

Generic Description.—In the year 1844, I communicated to the Geological Society a brief account of this and some other fossil fishes then recently discovered in the Oxford clay, at Christian Malford; but as no figure of this species is given in the Journal of that Society, and as I have since had the advantage of examining a larger number of specimens from the same locality, disclosing additional characters, I have thought it an appropriate subject for this decade. Before commencing the description of the species, I must allude to some anatomical details common to the genus, which have induced me to make some alterations in the generic characters assigned to it by Agassiz. He describes (Poiss. Foss., vol. ii. p. 13.) the teeth to be “en brosse, en avant des mâchoires; de plus grosses dans leur partie postérieure;” and at part 2, p. 129, “Ils ont des mâchoires armées de dents coniques, absolument comme les Sauroïdes.” After a careful examination of more than 100 specimens in my own cabinet, I have entirely failed to detect any trace of the conical teeth alluded to in the foregoing quotation. I am, consequently, inclined to believe that the teeth in this genus were exceedingly minute, so much so as to have perished in most cases with the integumentary investment of the jaws. The only allusion to the teeth in the specific descriptions of the *Leptolepides* in the “Poiss. Foss.” is to this effect: “Les dents ne sont visibles qu’à la mâchoire inferieure; mais elles sont si petites, que ce sont presque des dents en brosse.” This entirely coincides with the result of my own examination, and

is, I think, corroborated by the general form of the mouth, which I now proceed to describe. This organ is entirely bounded by the premaxillary (figs. 1, 2, *b.*) and lower maxillary bones. The former are very long, reaching, when the mouth is shut, as far back as the orbit; they are scimitar-shaped, the curve being backwards and upwards. The lower maxillaries are remarkable for having, at one third distance from the symphysis, a strong ascending coronoid process (figs. 1, 2, 3, *a.*) expanded at its upper extremity, and rising nearly at right angles from the dentary bone. In front of this process the bone is thickened out into a table, corresponding with a similar thickening of the proximal ends of the premaxillaries, and well adapted for the support of a cushion of minute villiform teeth. When the mouth is slightly open, the gape is defined by the anterior part of the premaxillaries, and that portion of the lower maxillary in advance of the coronoid process, and is nearly vertical; but when fully expanded the long premaxillary bones sweep forwards as far as the symphysis of the lower jaw, carrying with them a broad fold of integument, and forming a cavity nearly equal to the diameter of the entire head. The great length of the lower jaw behind the coronoid process provides the means for this enormous expansion of the oral orifice. This singular conformation of the lower jaw occurs in the *Carps* and some of the allied *Cycloid* fishes of the present day. That Agassiz is correct in arranging *Leptolepis* in the *Sauroid* rather than the *Lepidoid* family, I have little doubt; for on comparing it with other genera, I find that the allied genus *Thrissops* has also a coronoid process, though of smaller dimensions, with distinct *Sauroid* teeth, while the genus *Pholidophorus*, which is liable to be confused with *Leptolepis*, has the lower jaw of a very distinct form.

Description.—This species of *Leptolepis* is the most slender and elegant of the genus; the head partakes of the graceful character of the general form, being narrow and elongated. Its component bones are thin and perfectly smooth, with the exception of the preoperculum, which is characterized by coarse striations, radiating from its anterior margin. The orbit is large, but not so large (compared with other species) as I conceived to be the case when I gave the name to the species. The spinal column contains about 40 vertebræ; the terminal ones decrease rapidly in size, and trend slightly upwards. The ribs and the other vertebral apophyses are slender. The pectoral fins contain about 12 rays. The ventral fins are situated nearly in the centre of the body, and are comparatively large, containing each from 10 to 12 rays. The dorsal fin is small, and is directly above the ventrals. The anal fin is also small, and placed about mid-way

between the ventral and caudal fins. The latter organ is symmetrical; it has eight rays in the upper lobe, springing from the terminal vertebra, and three or four marginal rays above. The lower lobe has from eight to ten rays. The scales are small and very thin, finely sculptured with delicate, concentric striæ on the enamelled surface. This species differs from the following in its more elongated proportions and the relative small size of the head, as well as in the form of the centrum of the vertebræ.

Affinities.—The generic relations of *Leptolepis* are with *Thrissops* and *Megalurus*. Professor Müller considers the recent *Amia* to be a living representative of this section of the *Ganoid* order, and proposes to group them as a family of his *Ganoidei holostei*. The affinities of the species have been alluded to in the description.

Locality and Geological Position.—This fish appears not uncommon in the Oxford clay, at Christian Malford, associated with several other species of fossil fish, and with the cephalopodal remains so remarkable for the rare conservation of their more perishable parts.

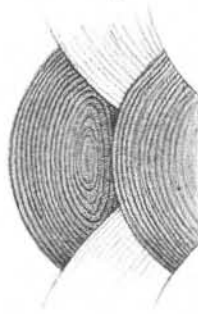
EXPLANATION OF PLATE.

- Fig. 1. Fish, the size of nature. *a.* coronoid process. *b.* premaxillary.
 Fig. 2. Specimen with the mouth open. *a.* coronoid process. *b.* premaxillary.
 Fig. 3. Specimen showing the under part of the head. *a.* coronoid processes.
 Fig. 4. Scales, magnified.

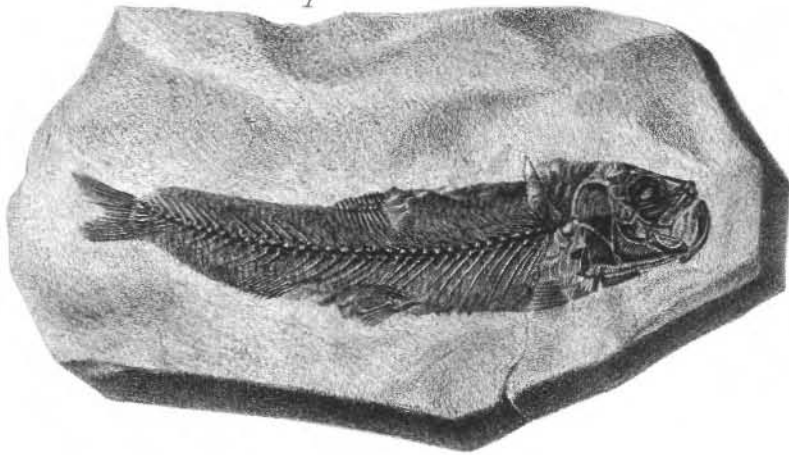
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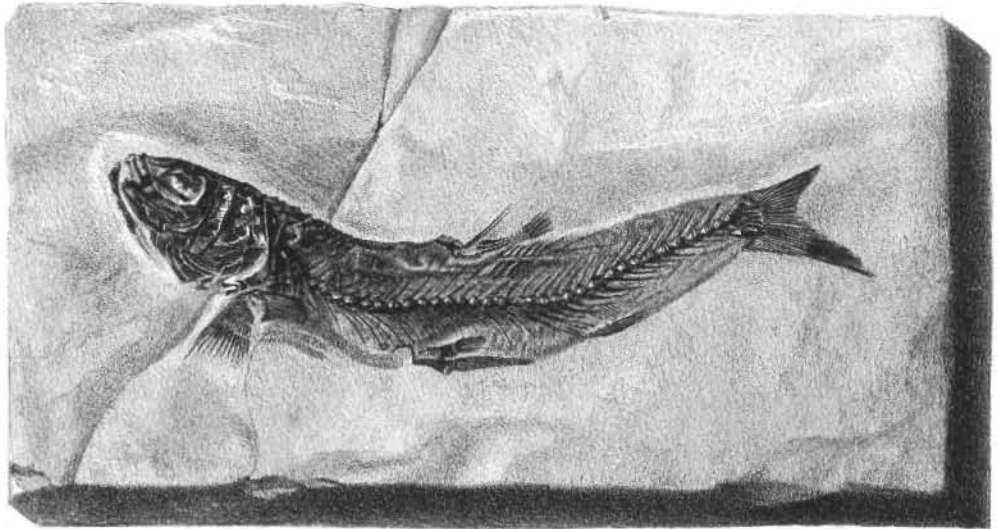
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LEPTOLEPIS CONSTRICTUS - Egerton

BRITISH FOSSILS.

DECADE VI. PLATE IX.

LEPTOLEPIS CONSTRICTUS.

[Genus LEPTOLEPIS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st Group. Tail forked.) Scales very thin and rounded; dorsal fin opposite the ventrals; operculum broad; sub-operculum large; teeth villiform; lower maxillaries with strong coronoid processes.]

Leptolepis constrictus, EGERTON.

Description.—The genus *Leptolepis* contains no fishes of magnitude, nevertheless, as some of the species are very minute, the range of size is considerable. *Leptolepis constrictus* holds an intermediate position in this respect. The largest of four specimens, which I have examined, measures $3\frac{1}{2}$ inches from the extremity of the nose to the fork of the tail. The head is small, occupying less than one fourth of the entire length, and of elegant form. Indeed, the whole fish is remarkable for the graceful proportions it displays. The bones of the head are exceedingly thin, and quite smooth, with the exception of the preoperculum, which is characterized by a fan-like group of prominent ridges, radiating from the anterior angle of the bone. This structure distinguishes the species very neatly from *Leptolepis concentricus*,* which has the preoperculum as smooth as the other cranial bones. The mouth is small, and opens upwards. The lower jaws are curved. No teeth are visible in the specimens I have seen, which, in other respects, are in a good state of preservation. The coracoid bone is strong and rounded. The spinal column consists of 38 vertebræ. These are longer than broad, and are remarkable for the depth of the constriction of the centrum between the articulations. Hence the specific designation. This constriction gives to each vertebra the form of an hour-glass. The relative position, size, and character of the fins in this genus vary little. In the species under consideration they are all small, and the rays slender. The pectorals contain about 19 rays in each fin,

* Egerton, Journal of Geol. Soc., vol. v. p. 35.

the ventrals 10, and the dorsal and anal 12. The caudal fin is bifurcate, the lower lobe being rather larger than the upper. The scales are oval, and their surface marked by numerous fine concentric lines, as in all the other species of the genus.

Affinities.—This species is distinguished from *Leptolepis concentricus* by the sculptured preoperculum, the greater tenuity of the scales, and the smaller size of the head. It has some resemblance to *Leptolepis Knorri*, found at Solenhofen, but has the head proportionately larger, the apophyses of the caudal vertebræ less inclined, and the form of the vertebræ very distinct. I have a specimen of *Leptolepis*, found in a liassic bed near Curcy in France, which very much resembles this species.

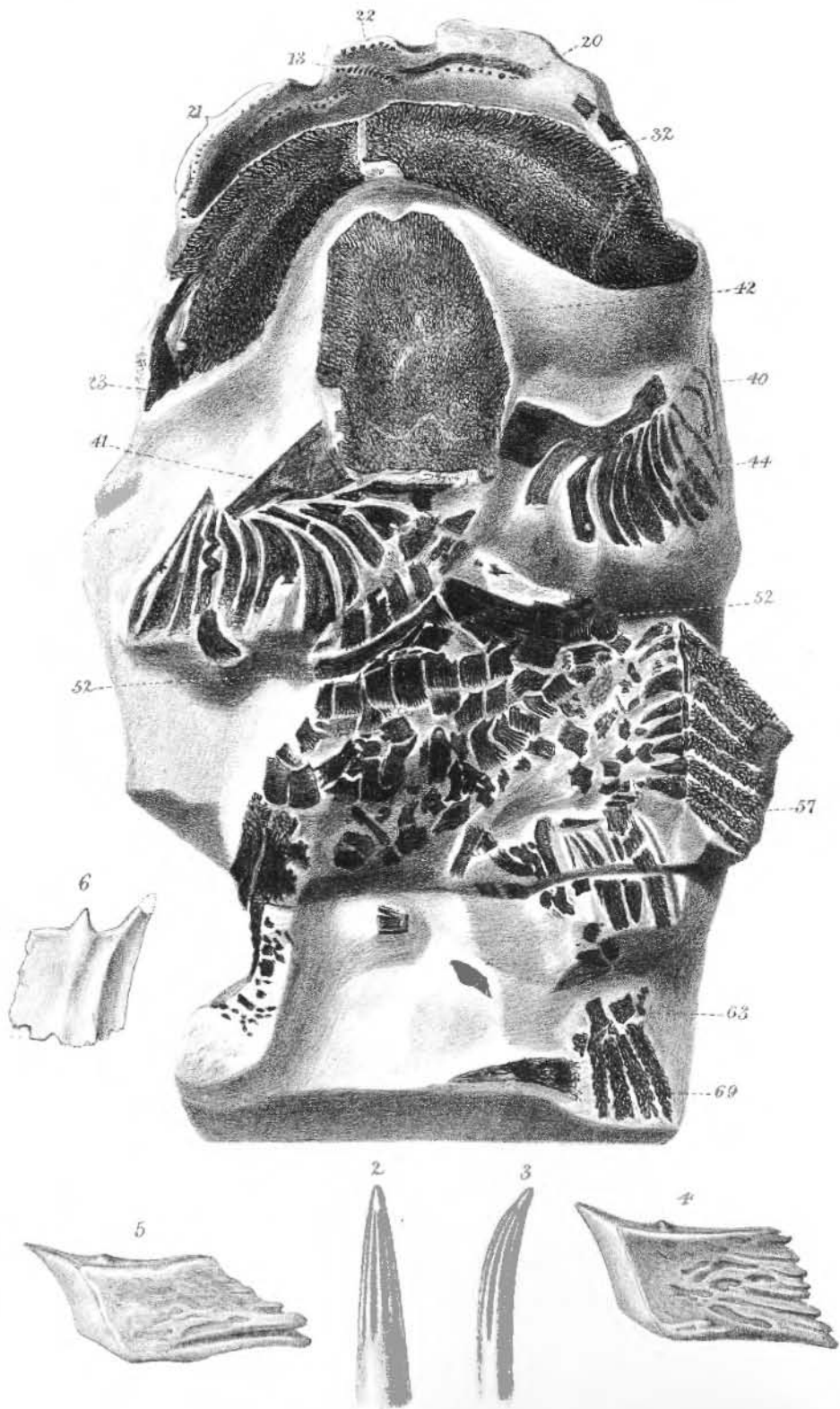
Locality.—All the specimens I have seen of this species belong to Mr. Moore, and were found by him in a bed of light-coloured lias near Ilminster.

EXPLANATION OF PLATE.

- Fig. 1. The fish, natural size.
Fig. 2. Another specimen.
Fig. 3. Scales, magnified.

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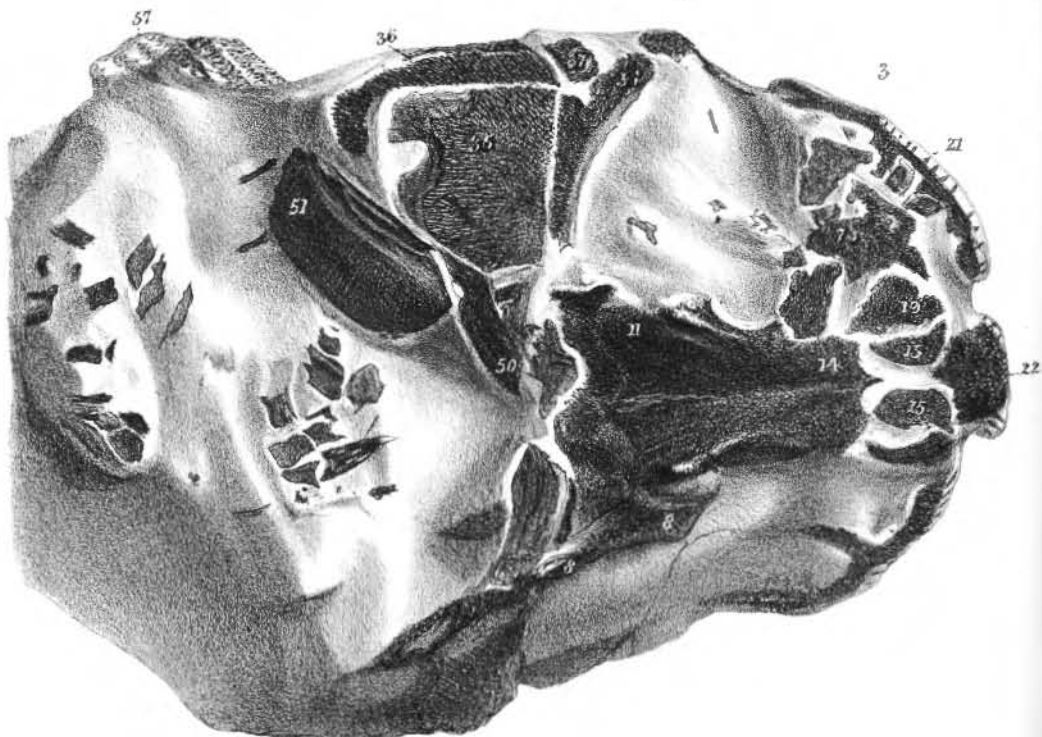
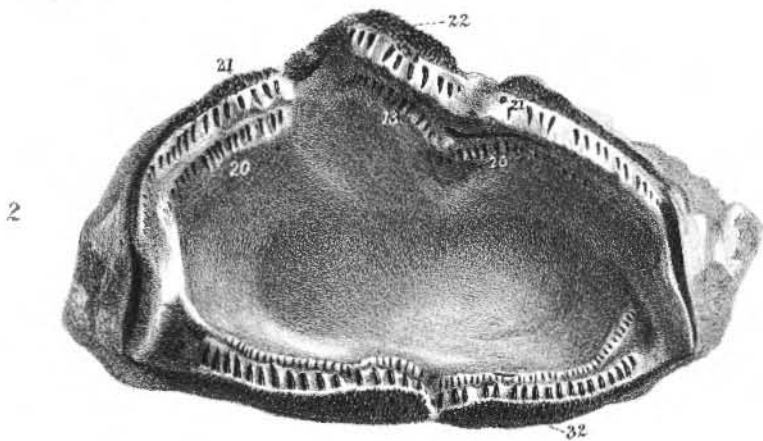
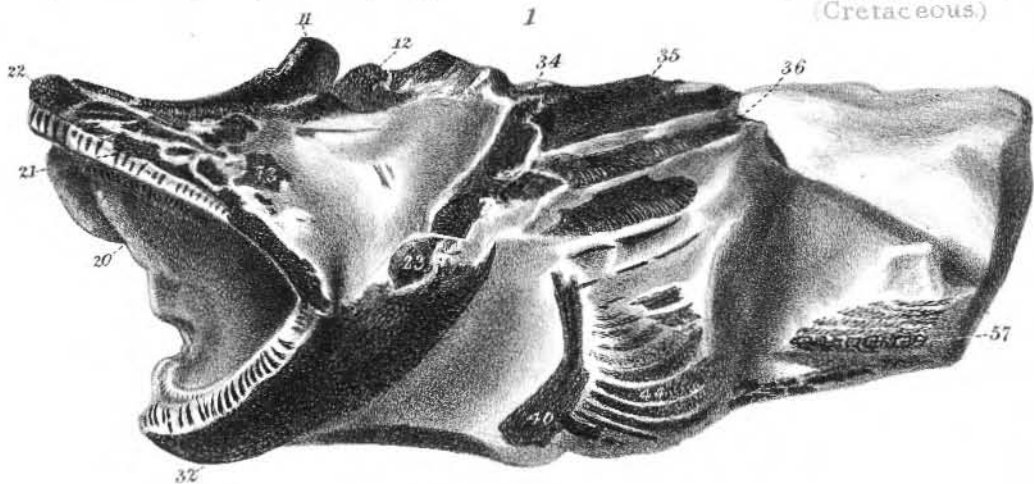


LOPHIOSTOMUS, DIXONI. — Egerton.

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LOPHIOSTOMUS.
(Cretaceous.)

Geological Survey of the United Kingdom.



LOPHIOSTOMUS DIXONI.—Egerton.

BRITISH FOSSILS.

DECADE VI. PLATES X., X*.

LOPHIOSTOMUS DIXONI.

[Genus LOPHIOSTOMUS (λοφιος, *lophius*, στομα, *os*). EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci.) Body short and thick; head depressed; mouth large, dichiscent; premaxillary and maxillaries with a single row of large, conical, incurved, grooved teeth; smaller teeth on the vomer and palatines; divided nasal; lower jaw deep, with an outer row of stronger and an inner row of weaker teeth; glossohyal expanded into a broad plate; scales rhomboidal, ganoid, pitted on the surface and serrated at the posterior margin.]

SPECIES UNICA.—*Lophiostomus Dixoni*, EGERTON.

Description.—In order to convey an adequate idea of this singular fish, it has been necessary to exceed the limits of illustration generally adopted in this publication. The two plates, from the masterly hand of Mr. Dinkel, contain four views of the specimen, together with magnified representations of the scales and teeth. The numbers used to designate the various bones are those employed by Professor Owen, in his writings on the homologies of the Vertebrate skeleton. It is not in this respect only that I am indebted to my distinguished friend; I have also to acknowledge the invaluable assistance he has afforded me in working out the details of this curious fossil, and his recognition of its affinities to the recent *Arapaima*. In form this fish was short, squat, and bulky, contrasting remarkably in these respects with the more or less elongated features of the abdominal predatory fishes, both recent and fossil, and recalling rather the similitude of a *Siluroid*. The head is wide and flattened, and measured probably more than a fourth of the entire length. The muzzle is broad and semicircular, projecting somewhat beyond the lower jaw; the gill-covers are large, and the branchiostegous rays of great strength. All these bones are invested with a dense layer of ganoine, having the surface raised into innumerable small prominences more or less confluent or distinct, resembling in this respect some recent *Siluroids* and fossil *Ganoids*. The frontal bones (Plate x*, fig. 11) form a large, somewhat triangular plate,

expanded towards the occiput, and bearing two remarkable prominences behind the orbits. Behind and beneath this projection, on the right side, is seen a strong process extending downwards and backwards (fig. 8). This, from its form and position, must be the mastoid bone; although, from the obliteration of all sutures, it is impossible to determine whether it is not partially composed of the postfrontal. Immediately in advance of the frontal bones are two small semilunar bones (fig. 15) corresponding to two semicircular emarginations of the anterior edge of the frontal plate, and two recessed facets of the premaxillary bone (fig. 22). With respect to these bones, Professor Owen writes as follows:—"I am now satisfied, from the way in which the bones or divided bone fit into the emarginations of the frontal, that they are the nasals, answering to the similarly divided but more elongated nasal of *Lepidosteus*." In following up this view the correctness of the identification becomes evident on examining the corresponding parts in the genera *Polypterus* and *Amia*, where we find the long narrow nasals of *Lepidosteus* represented by bones very similar in form to those of the fossil under consideration. External to these bones are two small ossicles (fig. 19), occupying the position of the "nasaux" of Cuvier. These are the turbinals of Owen, and correspond closely with these bones in the recent *Amia calva*. Several fragments of bone (fig. 73) occur between the turbinals and the upper maxillary, apparently belonging to a large lachrymal or suborbital bone. Immediately behind the upper portion of this bone a recess in the frontal bone marks the position of the orbit, and attests the absence of the supraorbitals which surround the orbit in *Lepidosteus*. The area of exposed chalk between the orbit and the preoperculum may have been occupied by a large postorbital plate, as in *Arapaima* and *Amia*. The upper jaw is composed of a single cuneiform premaxillary and of large arcuate maxillary bones, as in *Arapaima* (Plates x., x*, figs. 21, 22). Each of these components supports a single row of long, sharp, conical teeth, very regular in size, incurved at the points, and fluted on the surface. Within there is a second row of similar teeth, but rather smaller in size; the central ones are situated on the vomer (Plate x., fig. 13), and the lateral ones on the palatine bones (Plate x., fig. 20). The lower jaw is composed of long and broad dentary bones (Plates x., x*, fig. 32), with small articular ossicles (fig. 30) at the condyloid extremities. The teeth are of like character with those of the upper jaw, and equally regular, but they are implanted in a double row; those constituting the outer row being considerably larger than the secondary ones. The operculum (Plate x*, fig. 35) is of moderate

size and of triangular form, narrow above and broad below, as in *Lepidosteus*. The suboperculum (fig. 36) is long and narrow, and joins the operculum on a horizontal line. In front of this the remains of a small inter-operculum occur (fig. 37). The opercular apparatus is completed by a moderately-sized slightly curved preoperculum (fig. 34). This bone corresponds with the other bones of the head in superficial character, and is not, as is frequently the case, distinguished by a more bold and radiating style of ornamentation. The hyoidean arch is characterised by the great strength and expanse of its component parts. The ceratohyal bone (Plates x., x*, fig. 40) is flat and curved, and expands below into a broad spatula. It supports a series of 10 or 12 short falciform branchiostegals (fig. 44), the lower ones being shorter and broader than those which precede them. They partake of the enamelloid character common to all the other bones of the head. The most remarkable feature in the anatomical structure of this region, is to be found in the disproportionate development of the glossohyal or lingual bone, which is here expanded into a broad, oval disc, measuring $1\frac{1}{2}$ inch in length by 1 inch in width (Plate x., fig. 42), and occupying the entire space beneath the rami of the lower jaw when the mouth was closed. The position of the broad articular extremities of the ceratohyals, with reference to this plate, leads to the inference that it derived its support from these bones without the intervention of the basihyals. It is, however, very possible that the latter may either be confluent with the ceratohyals, as in the conger eel, or may support the base of the glossohyal plate. The scapular arch is for the most part concealed, but enough remains to show that it partook of the massive proportions of the adjoining parts. The scapula (Plate x*, fig. 51) is short and of great width, being flattened out into the resemblance of an operculum. It is smooth on the surface, a feature peculiar to this bone. The suprascapula (fig. 50) is smaller than the scapula, and of more slender proportions. The lower extremities of a pair of strong coracoid bones are seen in Plate x., fig. 52. The pectoral fin is unfortunately mutilated; enough, however, remains to indicate an organ of singular aspect and powerful proportions. It contained 10 or 11 rays of great strength, diminishing in size from first to last. They are invested with a dense coat of ganoine, composed of rugged imbricate tubercles, similar to those on the bones of the head, but much coarser; the rays are very close set, and are of like character; the first, although the largest, not exhibiting any distinctive features, such as are frequently found in some recent families. The appear-

ance in the plate of a series of carpal bones is deceptive, and is due to a fracture of the base of the fin and the removal of the outer surface of the rays. The ventral fins are abdominal, and situated very near the pectorals. They are comparatively small, containing four rays of similar appearance to the pectoral rays, but of slighter form. They are supported upon two pubic bones, of which the distal extremities only are preserved (Plate x., fig. 63.) The scales constitute a peculiar and valuable feature in considering the affinities of this fish, a subject which will be treated in the sequel. The dorsal and lateral series are for the most part absent, and the few that remain are inverted; the ventral scales, however, are in perfect state of preservation. They are quadrilateral, and more or less acutely rhomboidal, as in *Lepidosteus* and most of the fossil *Ganoïds*. They have a thick superficial layer of dense, lustrous ganoine, deeply and irregularly pitted and grooved on the surface, and terminate posteriorly in an uneven and coarsely serrated margin. The upper anterior corner of the root of the scale is produced to an acute angle, while the lower corner is rounded off to fit the corresponding angle of the succeeding scale. This compact adaptation of the adjoining scales to each other is still further secured by an articulating process on the upper margin of each scale lodging in a corresponding depression in the lower margin of the next in the series. This arrangement is identical with that in many of the genera of the fossil *Ganoïds*, and obtains also in the recent *Lepidosteus*. It is much to be regretted that no other portions of this fish have been preserved, since the position, form, and structure of the dorsal and caudal fins, and the character of the vertebral column are most important elements in determining its true character in relation to the other members of the class to which it belongs.

Affinities.—The generic title I have adopted for this fish has no reference to any real or supposed affinities with *Lophius*; it has been suggested solely by the disproportionate size of the mouth, so remarkable in both. In general features *Lophiostomus* is so unlike any fish, either fossil or recent, with which I have been able to compare it, that it must for the present be considered an isolated form. It possesses, nevertheless, some resemblances in structural details, both to fossil and recent forms, which point to an approximation of its true position in the scale of nature. With respect to the order to which this singular fish should be referred, there is fortunately no doubt. Thanks to the labours of the talented author of the Agassizian system, a single scale is decisive of its being a true *Ganoïd*. Again, the association of the rhomboidal scale, with

large predatory teeth, stamps it a member of the *Sauroid* family. As compared with other fossil members of this family, it approximates *Eugnathus* in the character of the scales, but differs from this genus and resembles *Caturus* in the uniformity of the teeth. Before I was cognizant of the scales, I was inclined to think it might belong to the *Cœlacanth*s. The bulky form and depressed head, the broad lower jaw, fluted teeth, and sculptured bones, are all features prevalent in that family; but the angular scales forbid this association, as the boundaries of these families are now defined. There are certainly exceptional forms among the fossil *Sauroids*, such as *Megalurus* and *Leptolepis*, with rounded scales, but these are combined with other characters preponderating in favour of the *Sauroid* relationship. On comparing *Lophiostomus* with recent fishes, the most striking features which naturally suggest themselves are the dentigerous maxillaries, the divided nasal, and the expanded lingual bone. The first peculiarity, namely, the part performed by the maxillary bone in the conformation of the upper jaw, is common to the *Clupeidæ*, the *Salmonidæ*, to *Lepidosteus*, and *Polypterus*, and to several genera of doubtful position, such as *Arapaima*,* *Amia*, *Hyodon*, *Megalops*, *Erythrinus*, *Macrodon*, &c. Most of these genera have also teeth on the vomer and palatine bones. The divided nasal is a structure of more limited occurrence. It obtains in *Lepidosteus*, *Polypterus*, *Amia*, *Arapaima*, *Heterotis*, *Erythrinus*, as also in *Megalichthys*, and some other fossil genera. The lingual, or submaxillary plate, the glossohyal of Professor Owen, occurs in *Elops*, *Megalops*, and *Amia*, but attains its maximum development in *Arapaima*. Among fossil genera, *Asterolepis* has this bone single; in *Holoptychius* and some of the *Dipterians* it is double as in *Polypterus*, while in *Megalichthys* and *Osteolepis* it is replaced by three plates. The combination of these features most in accordance with those in *Lophiostomus* occurs in the genera *Arapaima* and *Amia*. In reference to the former, Professor Owen wrote to me from Paris last autumn as follows: "Having your chalk fish still in view, I looked sharp at all the fishes' skulls at the Garden of Plants, and found almost its fac-simile in that of the great *Sulis* (*Arapaima*) *gigas*;—the same short premaxillaries, long dentigerous maxillaries, rear rank of shorter teeth on the vomer and palatines, divided nasal, broad glossohyal, numerous branchiostegals, and rough outer surface of the bone, &c.; the general shape much closer to the fish from Alfriston than the skull of *Lepidosteus* is, but clearly showing the same *Sauroid* or *Salamandroid* family construction." In some

* *Vastres*, Cuvier and Valenciennes.

respects the resemblance to *Amia* is also very remarkable, especially in the form and proportions of the divided nasal, and the turbinal bones, in the position of the orbit, the shortened antero-posterior dimensions of the cranium, the larger size of the teeth, and the absence of the deep pits characteristic of the head bones in *Arapaima*. The flattened head resembles that of *Polypterus*, and the scales and operculum those of *Lepidosteus*.

To recapitulate the peculiarities of *Lophiostomus*: it has the scales of a *Ganoid*, and the teeth of a *Sauroid*, associated with characters found in *Arapaima* and *Amia*, but differing from all these in outward form and proportions, and in these respects approximating rather to the family of the *Cœlacanth*s. It would be premature to attempt, from a single specimen, and that an imperfect one, to unsettle established generalizations, without sufficient materials to prepare a sound basis of re-adjustment. It is, however, clear that when the period arrives for a re-classification of many genera, both recent and fossil, now occupying somewhat doubtful positions, the subject of this description must form an essential element in the consideration. Cuvier has placed *Lepidosteus* and *Polypterus*, *Amia* and *Arapaima*, with the *Clupeidæ*; Agassiz considers the two former as *Sauroids*, the two latter, *Cœlacanth*s; while Müller places *Arapaima* with the *Clupeidæ*, and creates a new order, *Ganoidei holostei*, for the families *Lepidosteini* and *Polypterini*, and suggests a third family for the reception of *Amia*, combined with the fossil genera, *Megalurus*, *Leptolepis*, *Thrissops*, and their allies. This is not the place to enter upon a discussion of the many points raised in such a controversy, but we must hope that before long Professor Agassiz, who is now so opportunely located for studying some recent forms implicated in the question, may be able to effect a satisfactory settlement of these disputed points.

History and Geological Position.—The only specimen I have seen of this fish is in the British Museum. It was found in a chalk quarry near Alfriston, in Sussex, and was presented to the National Collection by Captain Beckford, R.N., of Ryde. I am indebted to my friend, Dr. Mantell, for the drawings of the specimen, made some years ago by Mr. Dinkel; and, in accordance with his wishes, I have named the species after the late Mr. Dixon, a tribute I am too happy to make to the memory of one whose friendship I long enjoyed.

EXPLANATION OF PLATES.

PLATE X.

- Fig. 1. *Lophiostomus Dixoni*, under view.
 Figs. 2. 3. Teeth, magnified.
 Figs. 4. 5. Upper surface of scales.
 Fig. 6. Under view of scale.

PLATE X*.

- Fig. 1. *Lophiostomus Dixoni*, side view.
 Fig. 2. Ditto ditto front view.
 Fig. 3. Ditto ditto upper view.

REFERENCE TO FIGURES.

- | | |
|-------------------|---------------------|
| 8. Mastoid bone. | 36. Subopercular. |
| 11. Frontal. | 37. Interopercular. |
| 12. Postfrontal. | 40. Ceratohyal. |
| 13. Vomer. | 41. Basihyal. |
| 14. Prefrontal. | 42. Glossohyal. |
| 15. Nasal. | 44. Branchiostegal. |
| 19. Turbinal. | 50. Suprascapular. |
| 20. Palatine. | 51. Scapula. |
| 21. Maxillary. | 52. Coracoid. |
| 22. Premaxillary. | 57. Phalanges. |
| 23. Articular. | 63. Pubic. |
| 32. Dentary. | 69. Ventral fin. |
| 34. Preopercular. | 73. Suborbitals. |
| 35. Opercular. | |

P. DE M. GREY EGERTON.

MEMOIRS

OF THE

GEOLOGICAL SURVEY

OF

THE UNITED KINGDOM.

Figures and Descriptions

ILLUSTRATIVE OF

BRITISH ORGANIC REMAINS.

DECADE VII.

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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.

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.

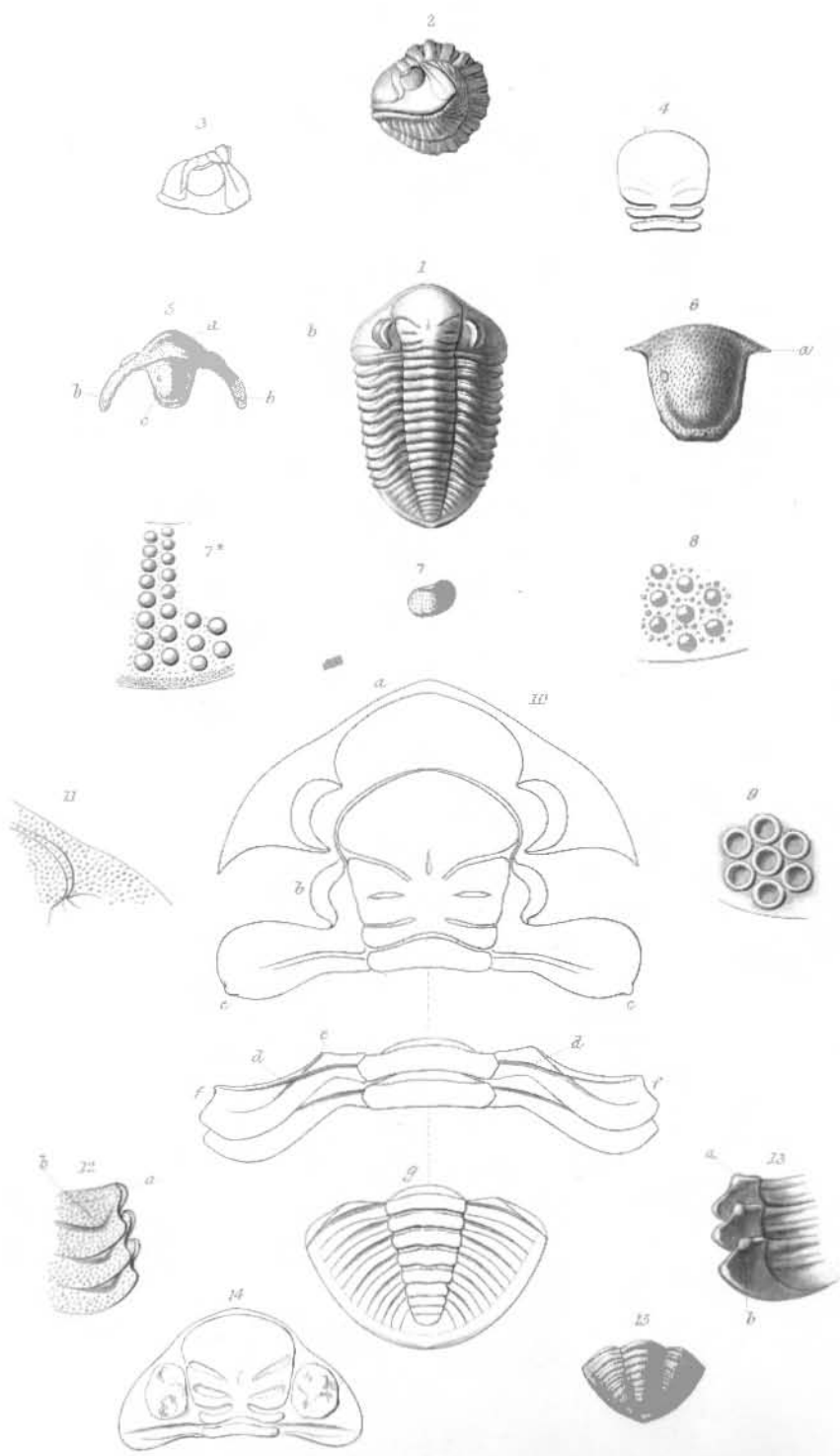
Remopleurides is republished, with some additional data for the correct account of its structure. It is proposed, for what appear to be cogent reasons, to refer some curious variations in closely allied forms to sexual differences.

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.

**THE
JOHN CRERAR
LIBRARY.**



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. Phillippsi*, 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. procerus*. 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-ar-y-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 subrecurvo; glabellâ ad basin contractâ antierius valde dilatâtâ nec convexâ, lobis utrinque tribus radiantibus; lobo antico maximo triangulato, a frontali sulco valido—a medio sulco leviori—sejuncto; lobis infimis minutis hemisphericis 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 levem 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 preccedenti similimus—caudâ multi-annulatâ, oculis maximis, glabellâ ad basin contractâ, granulosa; sed capitis fronte rotundato, nec producto; [an forsitan femina 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 dimidium 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 glabella, 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 paullum 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 anticè 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 axalibus 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^cCoy, 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-trigonalâ 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; Llanfyllin Glyn Ceiriog, south of Llangollen; Alt-yr-Anker, Meifod, North Wales [M'Coy], Welshpool [Sil. Syst.]; Llanfyllin, Montgomeryshire; Llanbedrog, Carnarvonshire [Survey Coll.]; Applethwaite 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 obsolete; axi lato nec eminenti, marginem caudæ haud attingente, in annulos sexdecim 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?).

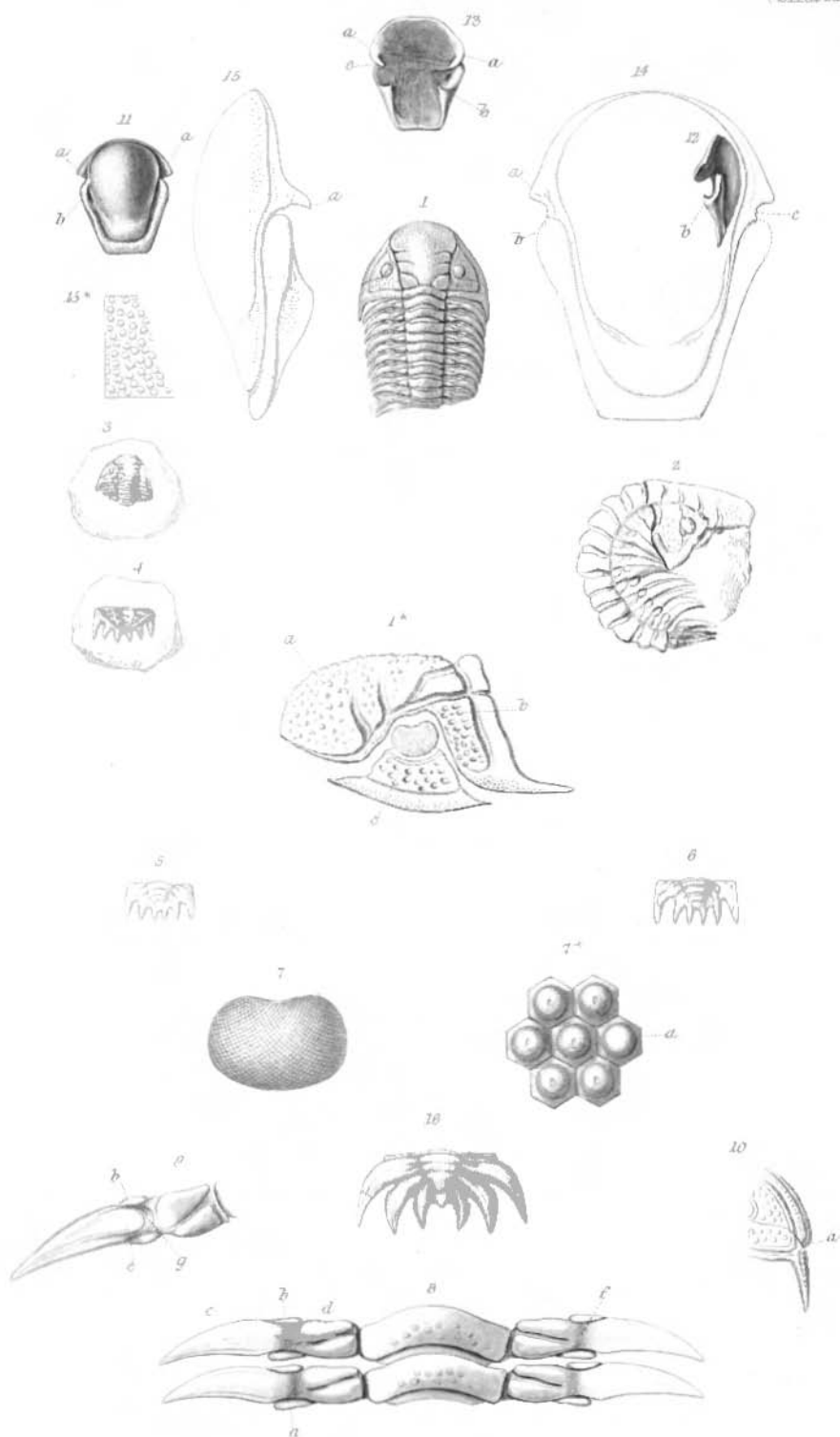
Very like in general form to *P. truncato-caudatus*, Portl., from which it is at once distinguished by its convex form (almost like that of a half cask or barrel), and the axis not at all distinct from the sides—the axial furrow being almost obsolete; this latter character is very unusual in *Phacops*. 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.

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BRITISH FOSSILS.

DECADE VII. PLATE II.

CHEIRURUS BIMUCRONATUS.

[Genus CHEIRURUS. BEYRICH. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadæ.) 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 oculo 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 Böhmisches 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.*, l. 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 Malverns 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. Forehead 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 *Sphærexochus*, 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 fuleral 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 Æland. 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, l. 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); (Eland, 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. *B. 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 Bæck, 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.)

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 æquali 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 ovatis.

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. *Cheirurus 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, granulosâ; 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, hâc 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.

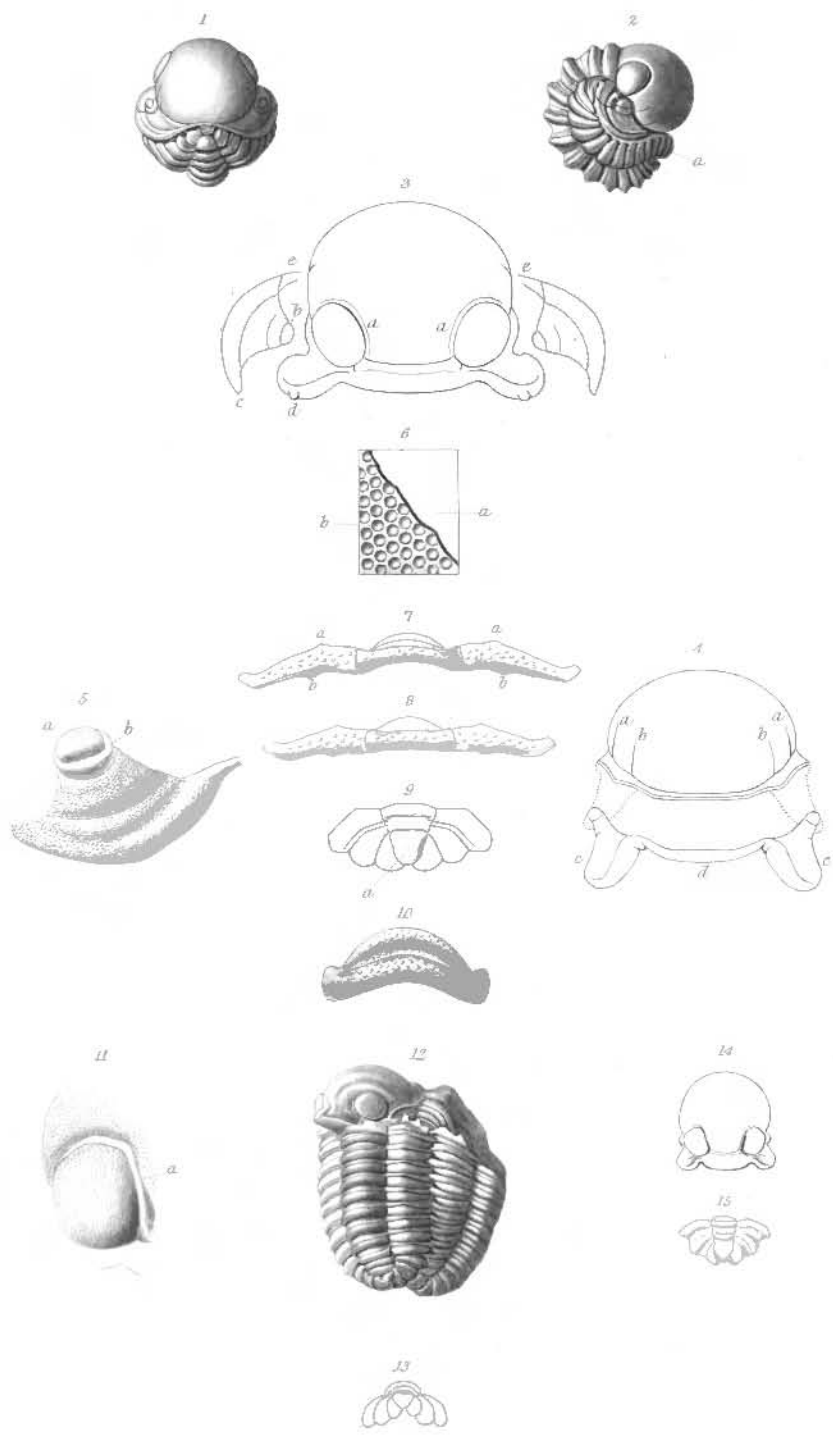
Localities.—Llandeilo and Bala rocks; in South Wales, Sholes Hook, Haverfordwest.

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.

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SPHÆREXOCHUS MIRUS. *Beyrich.*

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. granulosus*; "*glabellâ lobis infimis profunde circumcinctis, paullum 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 *Cheirurus*, 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 Furu-dal 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 supine 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.

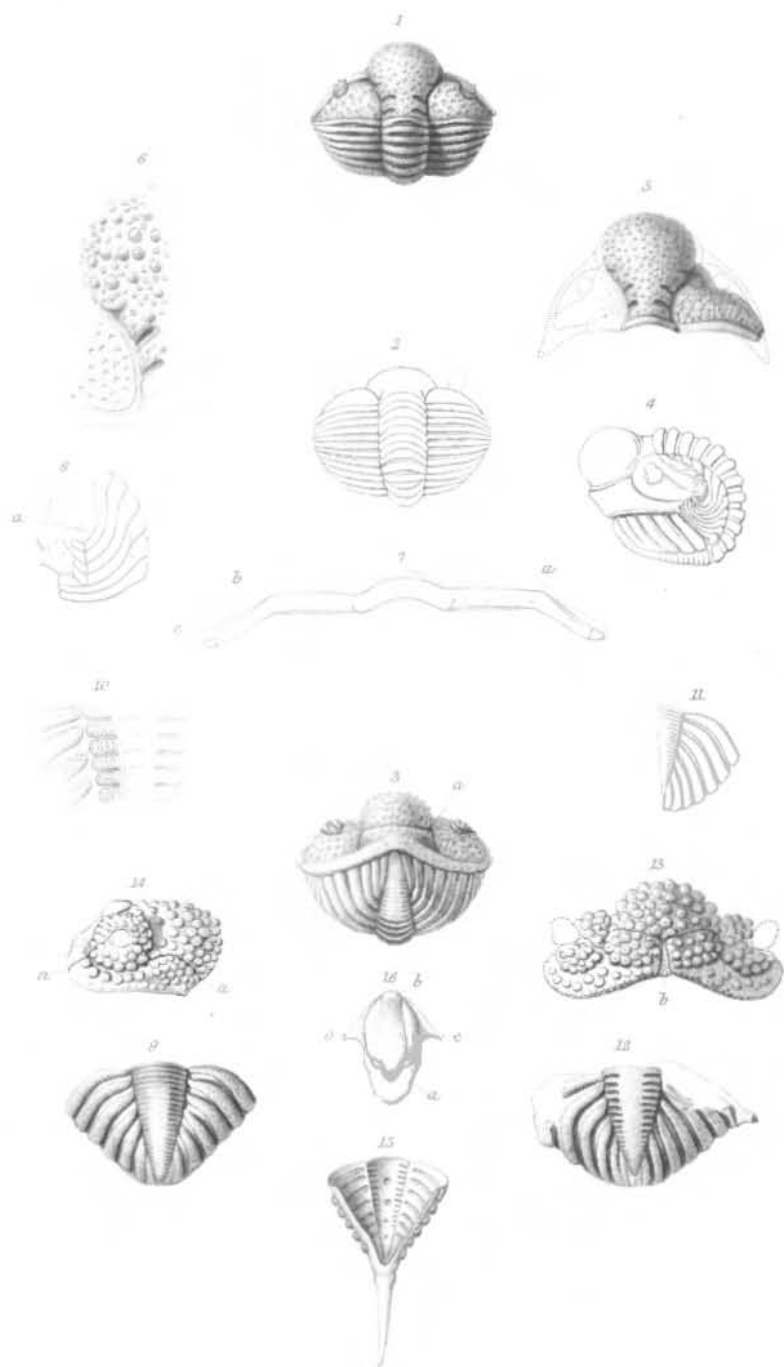
Remarks on the Genus.

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 *Sphæro-rochus*, 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.]

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August, 1853.

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Figs 1-13. ENCINURUS *Emmrichi*
SEX-COSTATUS *Salter*.

Figs. 14-18. E. VARIOLARIS *Brongnart*.
Figs. 16-18. E. PUNCTATUS *Brünnich*.

BRITISH FOSSILS.

DECADE VII. PLATE IV.

ENCRINURUS SEXCOSTATUS. Figs. 1 to 1X.

[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, Kutörga); 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; *ουρα* 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) obliteratis; 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 Kutörga 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 sexcostata*. 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 fuleral 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. Kutörga, 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. 5/

SYN. *Entomolithus paradoxus*, Linnæus, 1759, Act. Reg. Acad. Sc., Holm., p. 22. t. 1. f. 2. *Tril. punct.*, Brünn., Kjobenh. 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. ovatus, biuncialis; glabellâ clavatâ convexâ sed parum inflatâ tuberculosâ; tuberculis anticis paullo 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 paullo 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. *α*. *Calcareus*.—Caudâ in mucronem planum seu recurvum producto.

Var. *β*. *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 Llandeilo 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*, Brongn. sp. ^{Pl. 4. f. 13, 14.} *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, sesquincialis, capite et thorace E. punctato simillimis, sed glabellâ inflatâ, nec anticâ 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 dispositis 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. sesquincialis, 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.

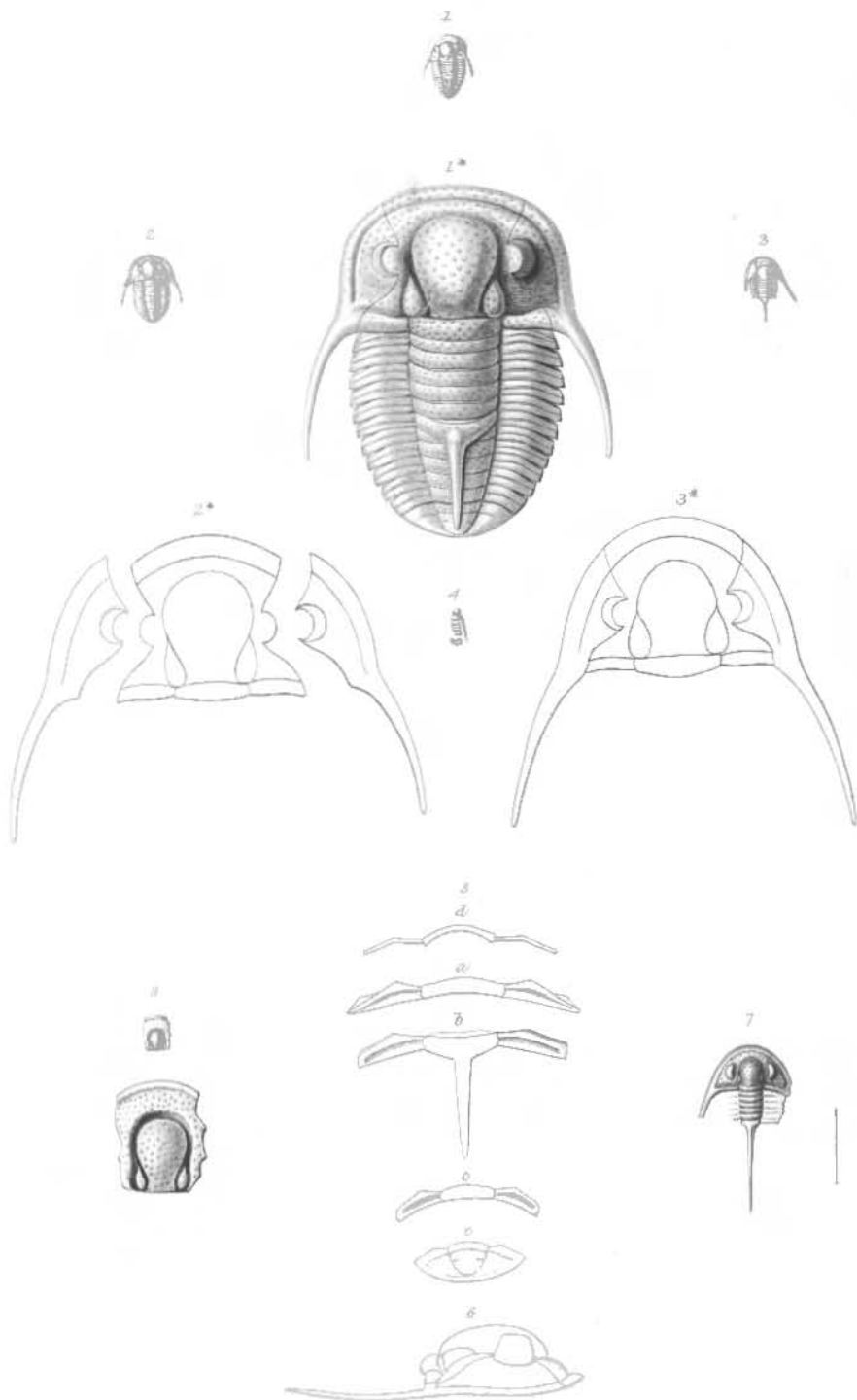
The crest of large tubercles, parted in the middle, along the front of the glabella, as well as the numerous ribs of the tail, are good marks of this elegant species. There can be no doubt the two portions above cited belong to each other.

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

J. W. SALTER.

August, 1853.

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CYPHASPIS MEGALOPS — *M. 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 granulate, 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 *Cymothoadæ*, a group of Isopod crustacea very analogous, 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 sub-genus. 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.

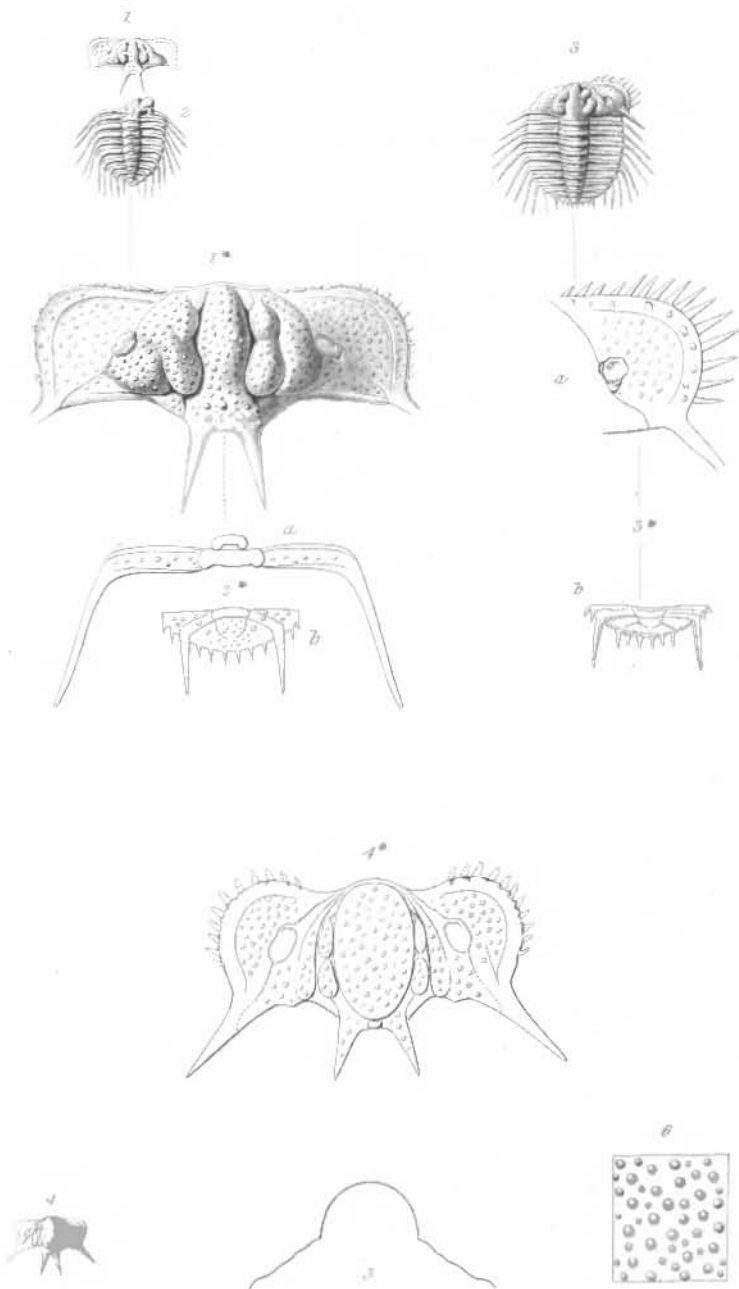
The characters above mentioned may be those of a young specimen; but it has the full number of rings, and in this genus they increase in number with age; the head is not nearly so produced in front, nor the glabella so convex as in *C. elegantulus*, and the head spines are proportionally much longer; 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.

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1, 3 ACIDASPIS JAMESII — Salter.

4, 6 ASPINOSUS — M^r. 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 Palæadæ.) 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. *ακίς*, mucro; *σπίς*, 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. Emmrich 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 *Trinuclæus*, 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. Emmrich, 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 à 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, glabellâ lobo mediano ovali gibbo per totum capitâ extenso, lobis lateralibus utrinque tribus minutis linearibus; oculis ante medium genarum positâ; cervice bispinosa.*

SYNONYMS. *A. bispinosus*, M'COY (1846), Synopsis Sil. Foss. Ireland, pl. 4. fig. 7. (not *Odontopleura bispinosa*, EMMRICH, 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. Barrandii*, 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 (*Dissertatio 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 aequante 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 paulum divaricatis, terminalibus minutis 6, externis 2 (vel 3); axi convexo.

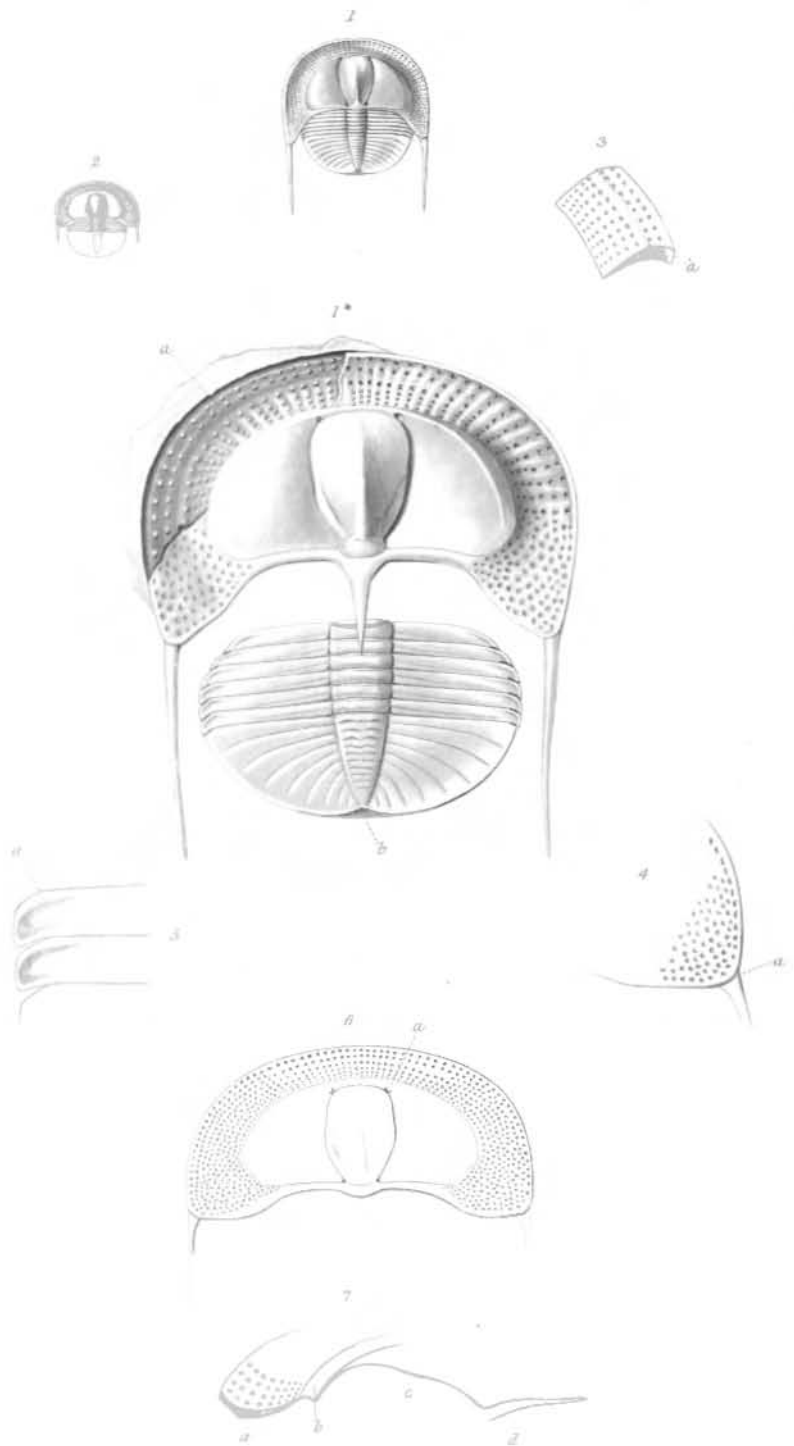
Locality.—Gretton quarry, near Cardington; a locality rich in all the characteristic Bala species. *Lichas laxatus*, *Phacops conophthalmus*, and *P. truncato-caudatus*, *Calymene Blumenbachii*, *Illænus*, &c. occur with it.

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.

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TRINUCLEUS LAOSDII *Marchison*.

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 Mc'Coy 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), 103, 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*, fuleral 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. *Ampyx* (*Cryptol.*)

Caract., Emmer. (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 angustiore, punctis ad frontem subradiatis et in ordines 3 contractis; glabellâ subclavatâ genis paullo angustiore, 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 longiore, 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 *Trinucleus* 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. concentrica* 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 Lihwyd'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 paululum angulato, glabellâ genis depressis longiore angustissimâ valde elevatâ et acuticarinatâ; fimbria angustâ, planâ nisi lineâ medianâ paullo 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. Succ., 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 longispinis, 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 capitis haud expansis, spinis brevibus tetragonis divergentibus; thorace abbreviato; caudâ thorace brevior, subtriangulatâ, lateribus leviter 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 Builth 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 capitis 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.

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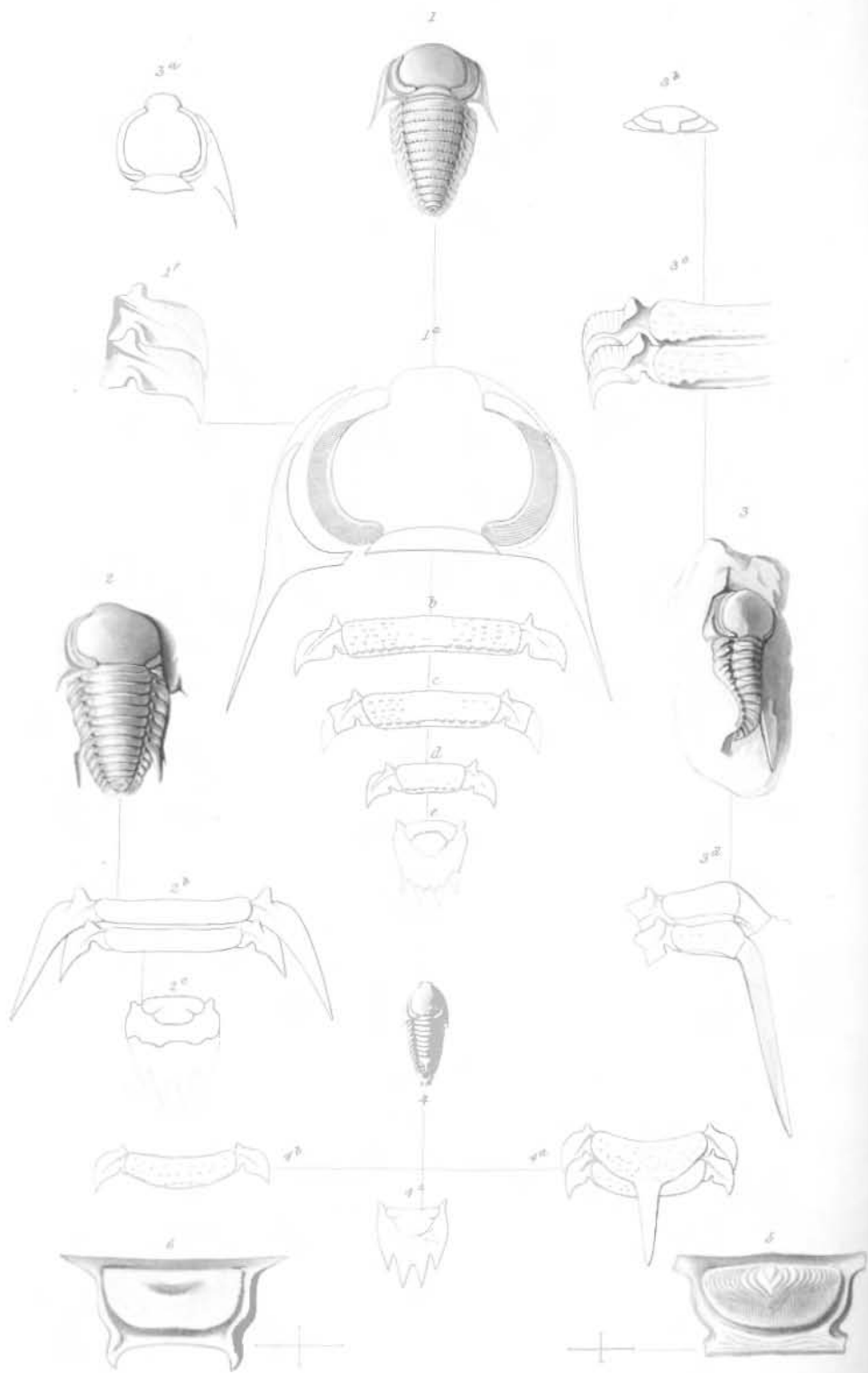


Fig. 1. REMOPLEURIDES COLVII Portlock

2 R ——— LATERISPINIFER D'

Figs. 3, 4. R ——— DORSOSPINIFER ——— Portlock

5, 6. ——— Hypostome of Remopleurididæ

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 spines; 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, α); 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 transverse 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 præcedenti habendus.)

SYNONYMS. *R. laterispinifer*, PORTLOCK (1843), l.c., pl. 1. fig. 2. M'COY (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 Bardalnessagh, 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* (*Odontopleura*), 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 fulera * * ; 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.—Tirnaskea, Tyrone, in sandy schist; Tramore, Waterford, in dark slate; Chair of Kildare, county of Kildare, in limestone. LLANDEILO OR BALA BEDS.

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

R. parvulus, glabellâ lyratâ subconvexâ elongatâ, anticè latissimâ, oculis abbreviatis vix 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. sesquiuncialis (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 falcatis, fere axin convexiorem æquantibus, fulcro proximo; caudâ longâ, quadrispinosâ, spinis externis longioribus.*

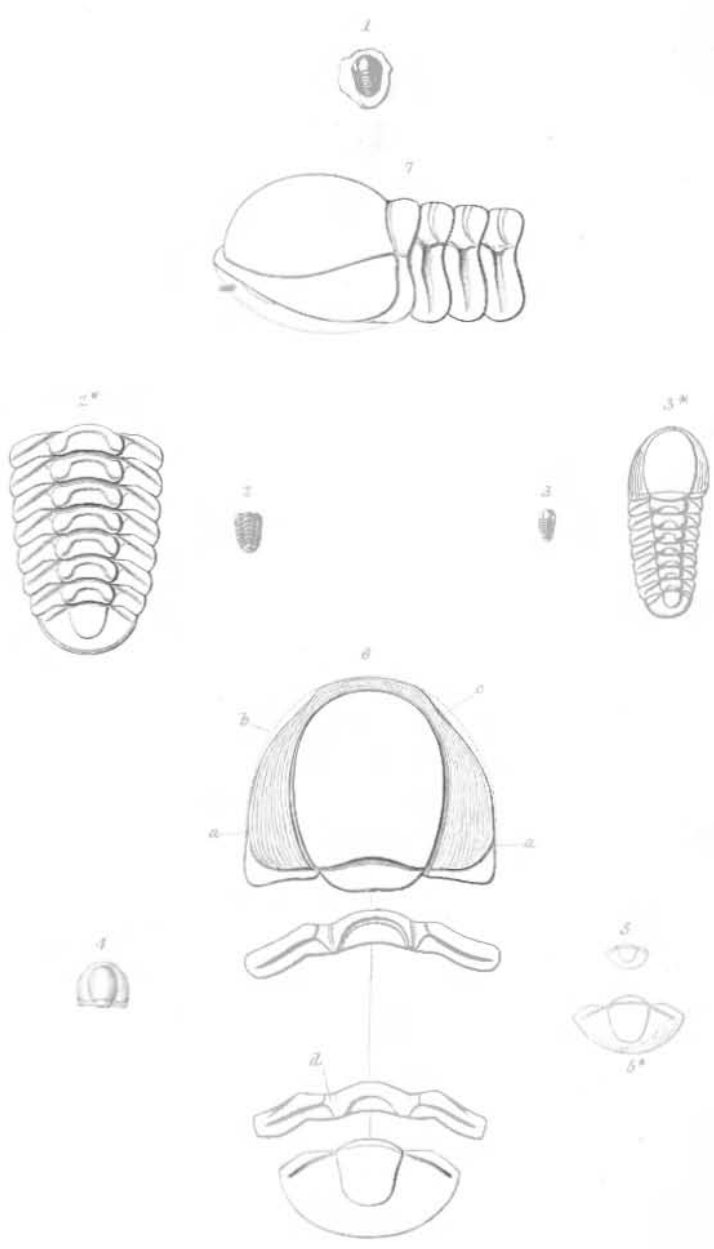
M. de Barrande, when in England, agreed with us in identifying this species; and we adopt the above specific name, believing it to be but common courtesy, when correcting the mistake of a careful and judicious author, to retain the name he imposed. M. de Barrande, it is true, described as a tail the 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.

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CYPHONISCUS SOCIALIS — *Salter.*

BRITISH FOSSILS.

DECADE VII. PLATE IX.

CYPHONISCUS * SOCIALIS.

[Genus CYPHONISCUS. SALTER. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadaæ.) 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 ὄνισκος, 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.

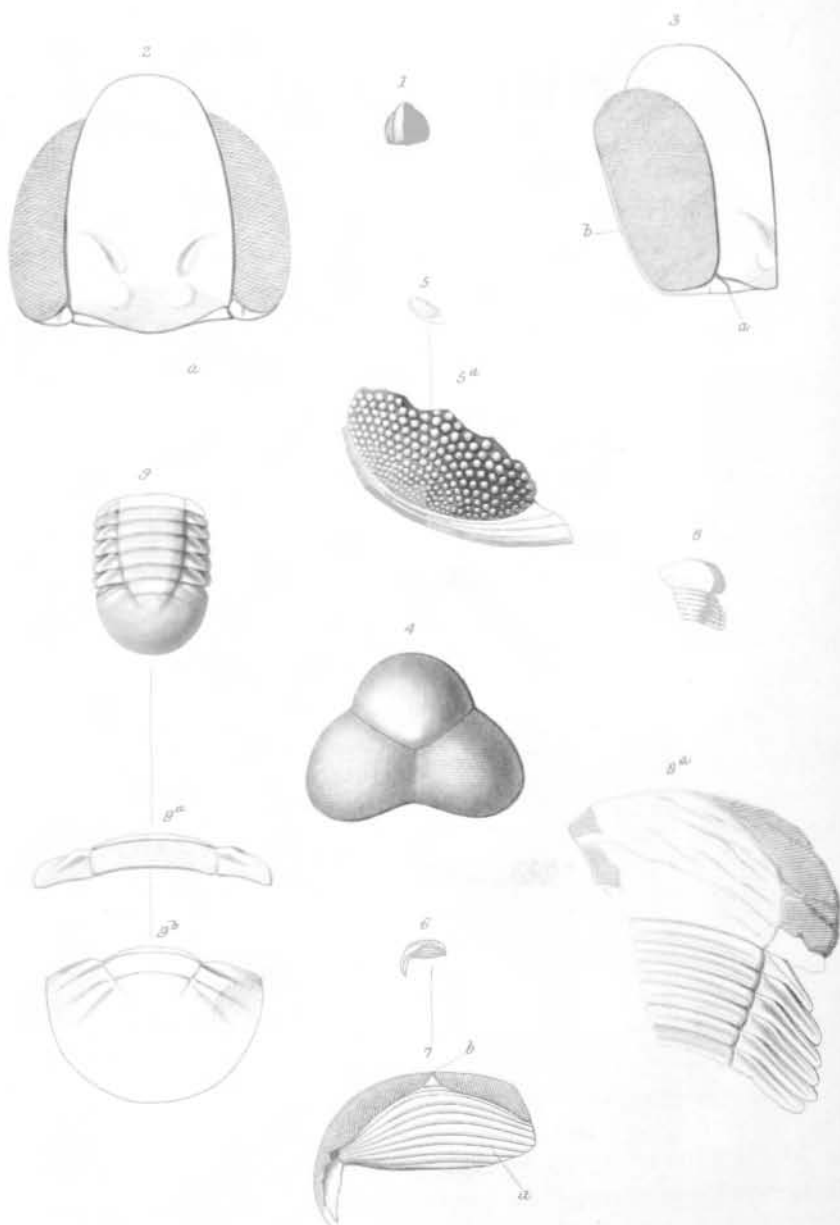
EXPLANATION OF PLATE IX.

- 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.

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Figs. 1-9. ÆCLINA 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 Palæadæ.) 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

* Prodrome 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).

ÆGLINA—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, lævigata; 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 tranverse 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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P R E F A C E.

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.

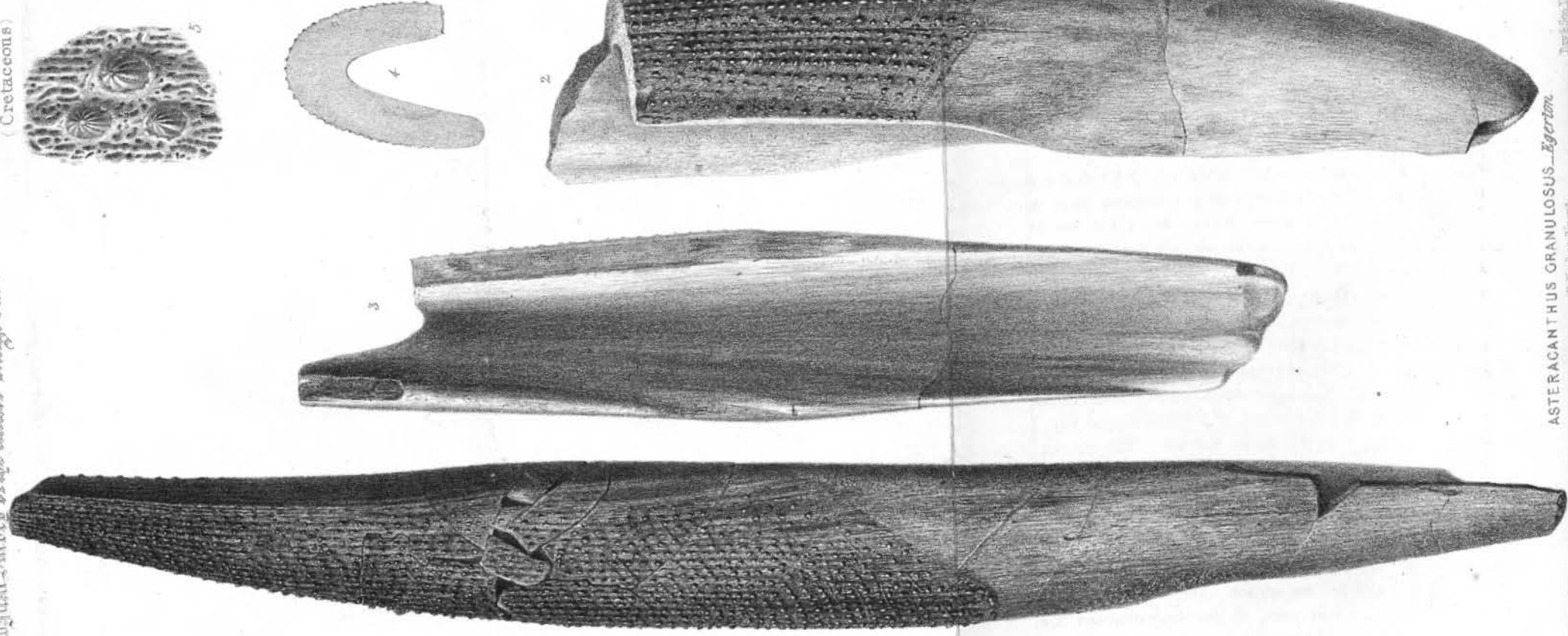
2nd April 1855.

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 Cestraciontidae.) Dorsal spine large, tuberculate, with a double row of processes on the posterior margin ; base smooth.]

Asteracanthus granulatus, SP. NOV.

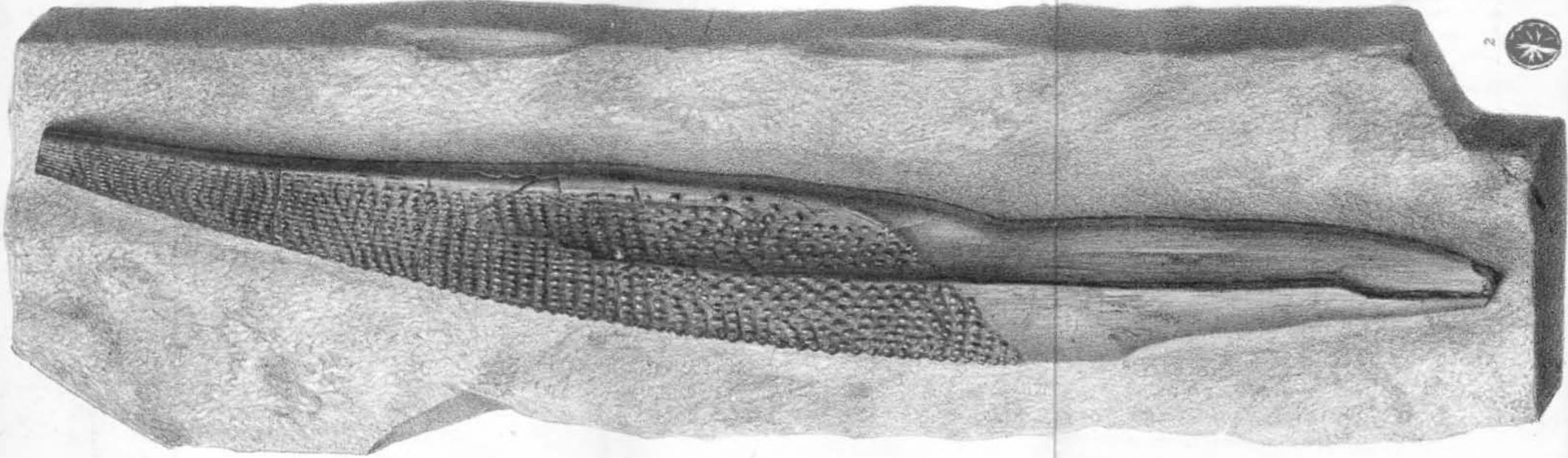
Description.—The characters assigned by Professor Agassiz to the genus *Asteracanthus*, are striking, constant, and unmistakeable. The leading features of these Ichthyodorulites are the tubercular surface of the dorsal ray, and the stellate ornament of the tubercles. In the typical species, *Asteracanthus 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 granulatus*, size of nature.
- Fig. 2. *Asteracanthus granulatus*, size of nature.
- Fig. 3. Interior of ditto.
- Fig. 4. Transverse section of ditto.
- Fig. 5. Portion of No. 1 magnified.



1

2



BRITISH FOSSILS.

DECADE VIII. PLATE II.

ASTERACANTHUS VERRUCOSUS.

[Genus ASTERACANTHUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Placoidei. Family Cestraciontidae.) 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 10½ inches, but the apex is wanting to the extent of perhaps ½ 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.

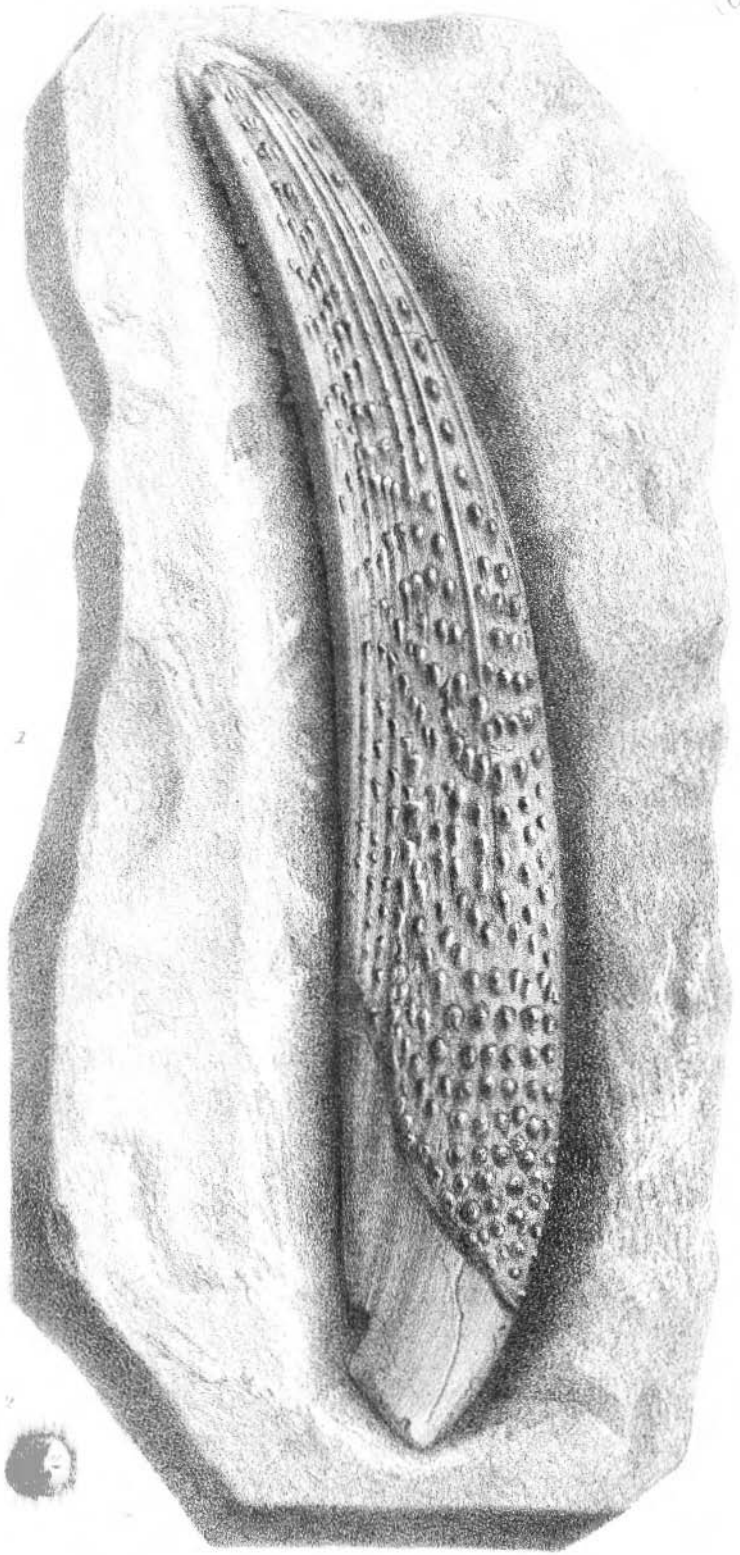
Fig. 2. Tubercle, magnified.

P. DE. M. GREY EGERTON.

May 1853.

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ASTERACANTHUS
(Oolitic)



ASTERACANTHUS SEMIVERRUCOSUS — Egerton.

H. Forbes, del. et sculp.

Day & Son Lith.

BRITISH FOSSILS.

DECADE VIII. PLATE III.

ASTERACANTHUS SEMIVERRUCOSUS.

[Genus ASTERACANTHUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces Order Placoidei. Family Cestraciontidae.) 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 Purbecensis* 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.

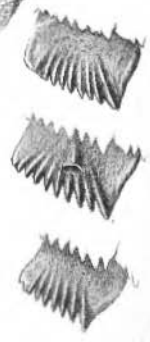
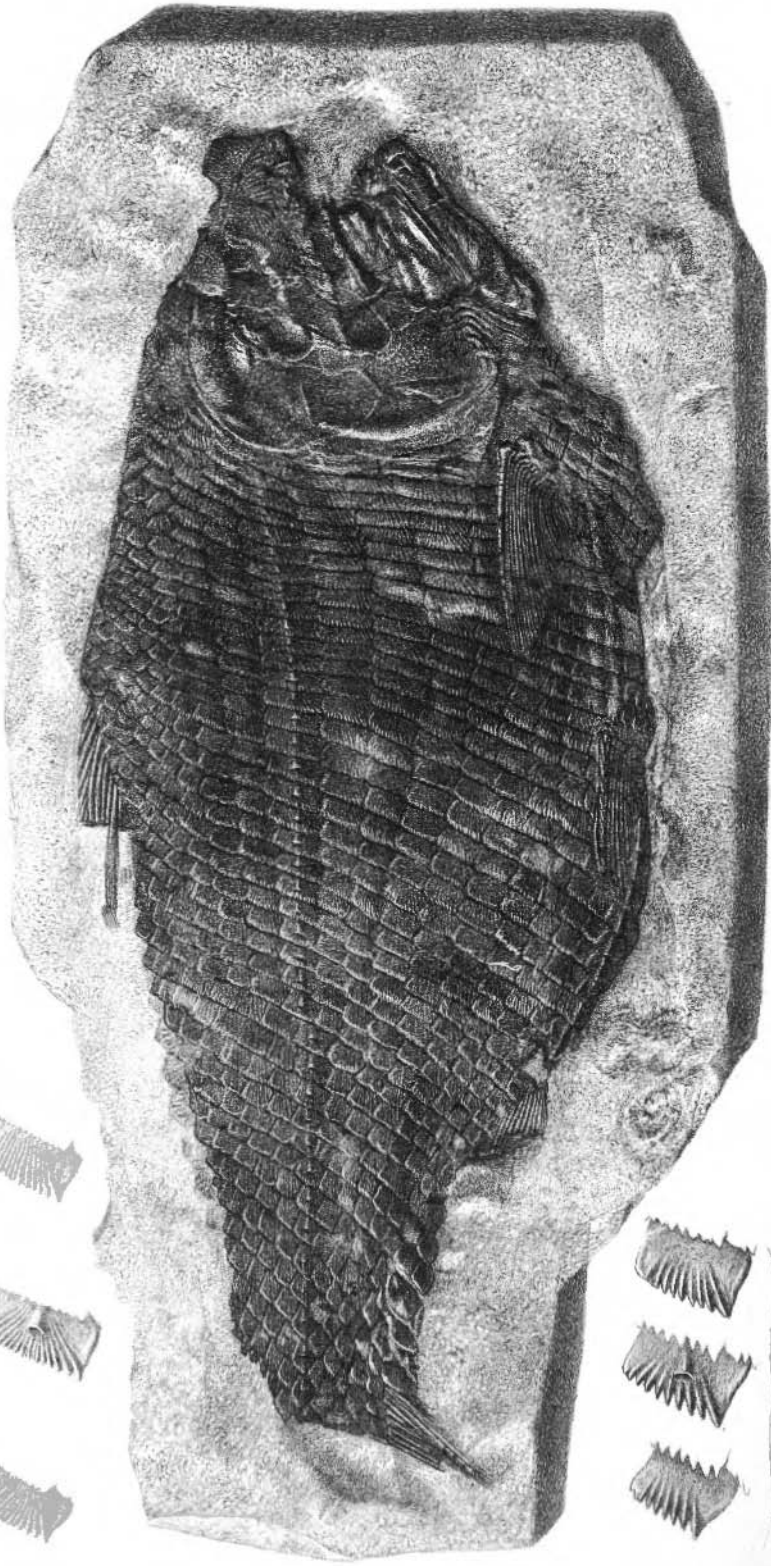
P. DE M. GREY EGERTON.

May 1853.

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PHOLIDOPHORUS.
(Colonic.)

2



3

PHOLIDOPHORUS GRANULATUS — Egerston.

3. Scales, three.

J. G. Drake del.

Drawn from the original in the Queen's

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.

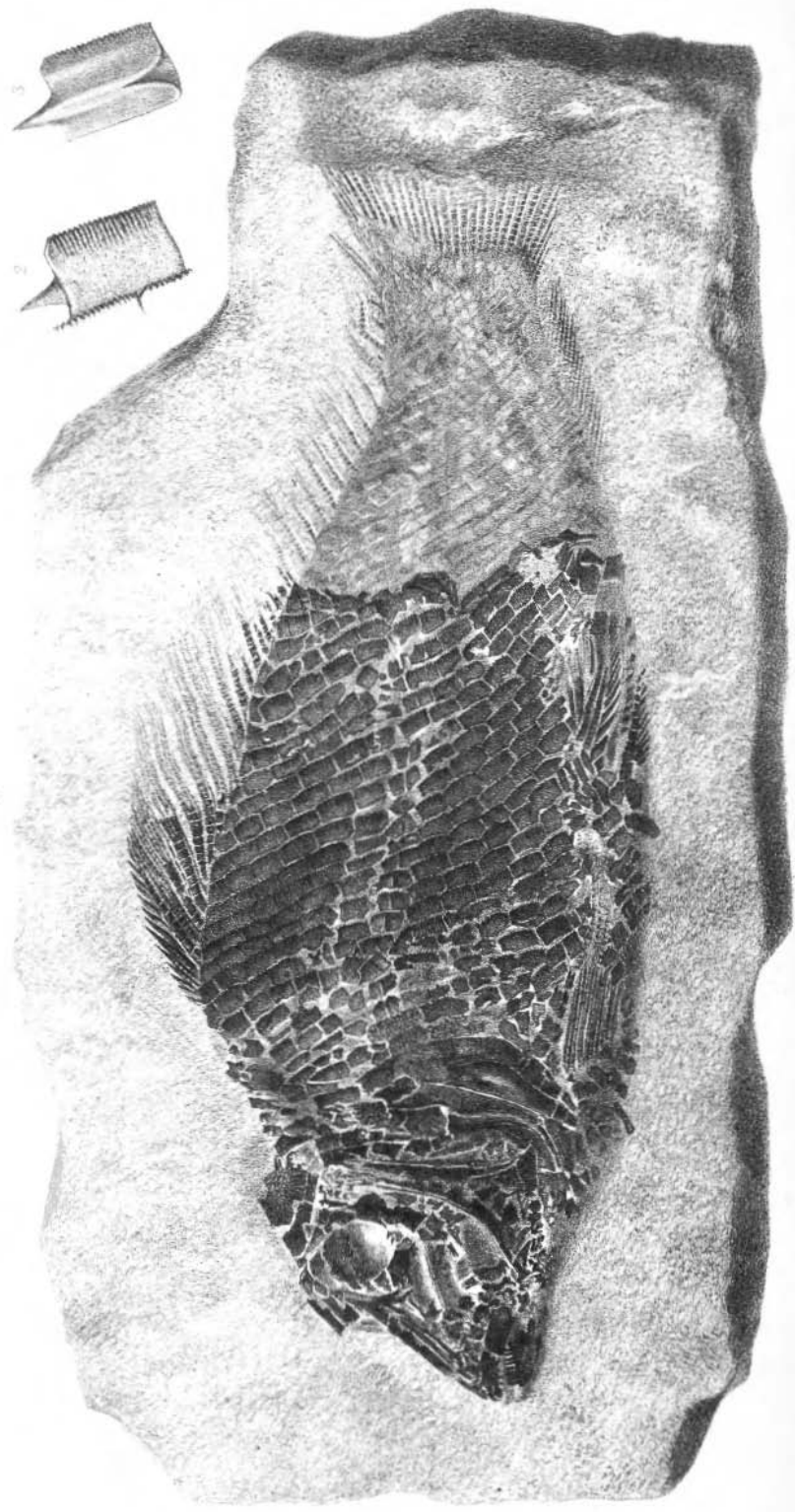
P. DE M. GREY EGERTON.

July 1853.

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HISTIONOTUS.
(Oolitic)

7



HISTIONOTUS ANGULARIS — Egerton.

The Natural Hist.

E. Forbes del. & sculp.

Printed by Wm. Litherly & Co. The Queen.

BRITISH FOSSILS.

DECADE VIII. PLATE V.

HISTIONOTUS. GEN. NOV.

[Genus HISTIONOTU (*ἱστῖον*, 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 ganoiné. 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.

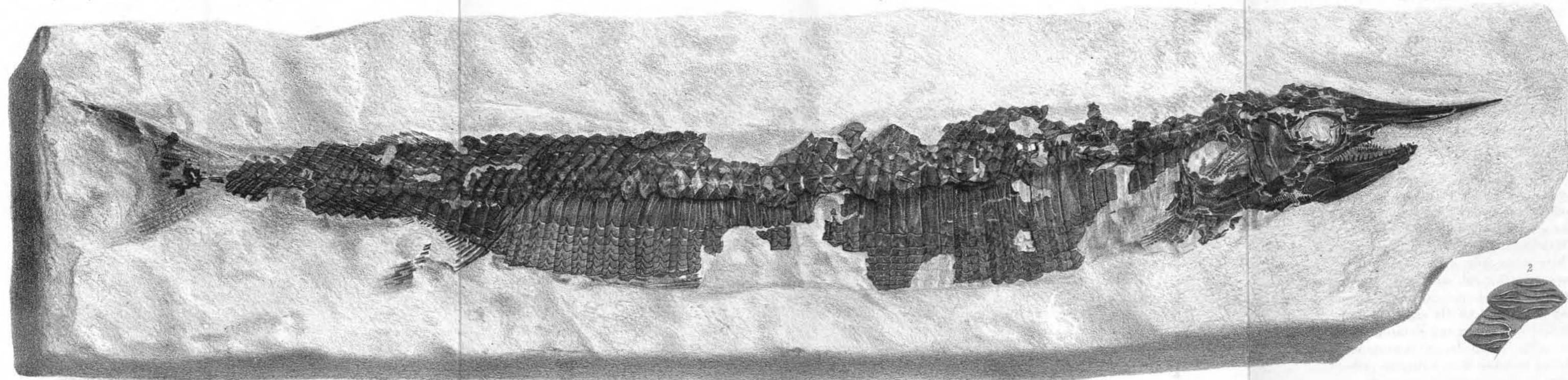
Fig. 1. *Histionotus angularis*, size of nature.

Fig. 2. Scales, magnified.

Fig. 3. Under surface of scale, magnified.

P. DE M. GREY EGERTON.

May 1853.



ASPIDORHYNCHUS FISHERI — Egerton

H. Forbes, direct.

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 $3\frac{2}{10}$ 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.

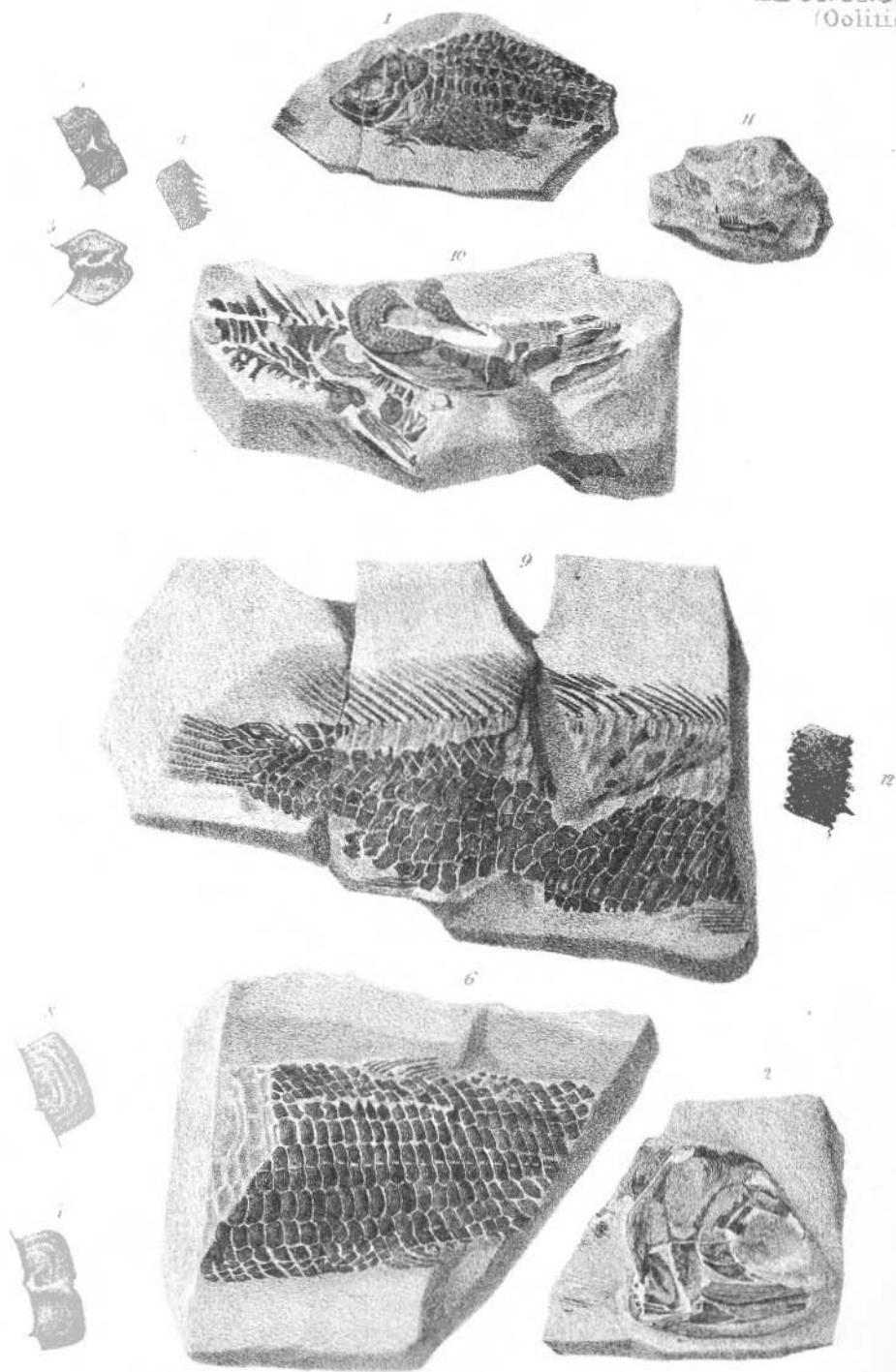
Fig. 2. Dorsal scales, magnified.

P. DE M. GREY EGERTON.

June 1853.

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PHOLIDOPHORUS
LEGNONOTUS.
(Oolitic.)



1-5. PHOLIDOPHORUS HIGGINSI — *Stutchbury* 6-12 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 Goniotepidoti. 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 ganoine. 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.

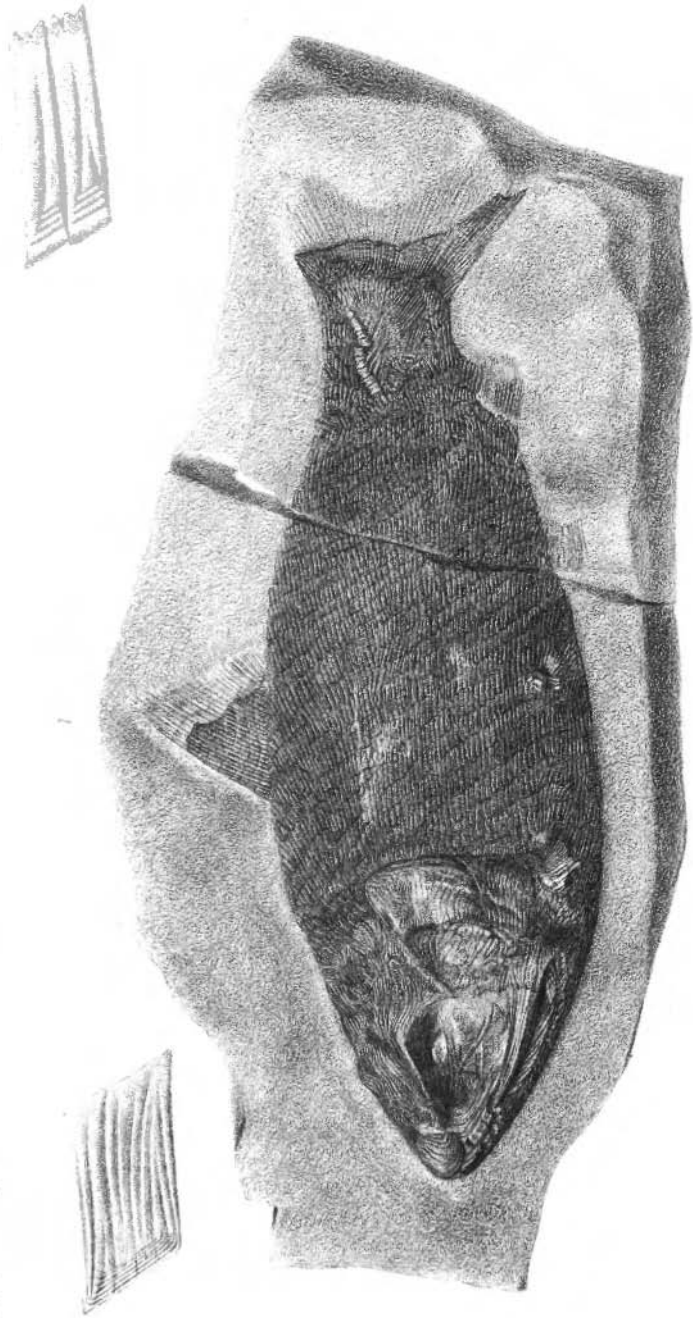
P. DE M. GREY EGERTON.

July 7, 1853.

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PTYCHOLEPIS
(Coelocia)

Geological Survey of the United Kingdom.



PTYCHOLEPIS CURTUS — *Egerton.*

H. Forbes delin^s

Geol. Surv. Brit. Mus. Geol. Dept.

See Dinkel lith.

BRITISH FOSSILS.

DECADE VIII. PLATE VIII.

PTYCHOLEPIS CURTUS.

[Genus PTYCHOLEPIS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. 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 vertebrae 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.

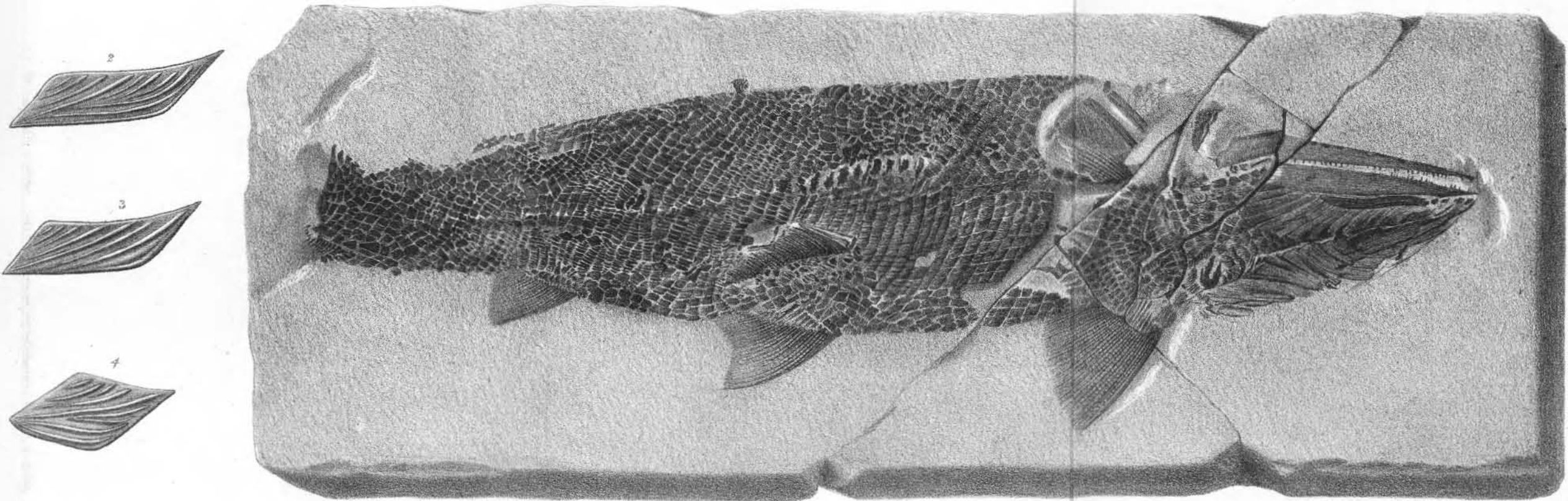
EXPLANATION OF PLATE.

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

Fig. 2, 3. Scales magnified.

P. DE M. GREY EGERTON.

May 1853.

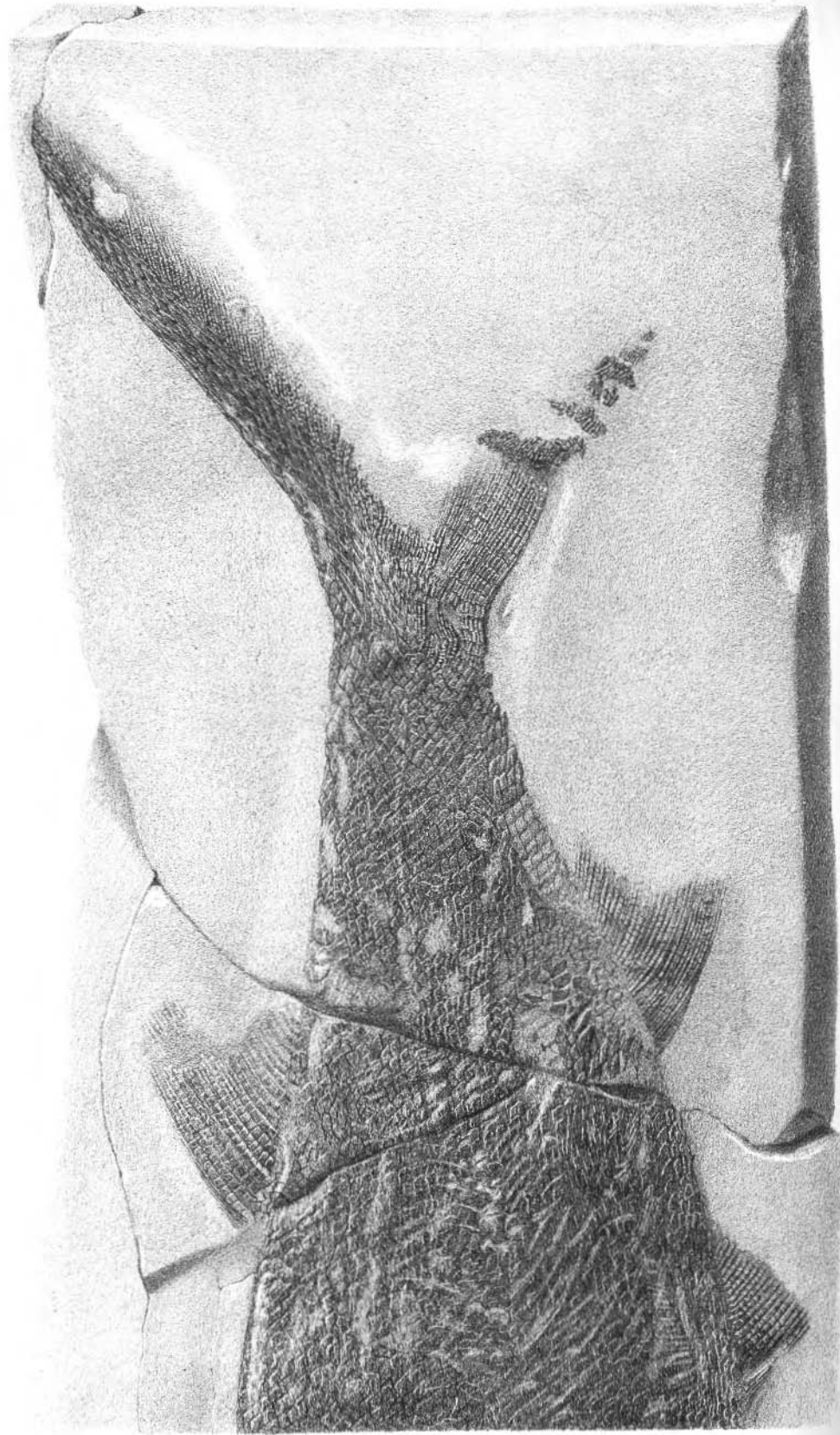


OXYGNATHUS ORNATUS — Egerton.

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Geological Survey of the United Kingdom

PLATE 6
ORNALES
(Outline)



ORNALES ORNALES

BRITISH FOSSILS.

DECADE VIII. PLATE IX.

OXYGNATHUS. GEN. NOV.

[Genus OXYGNATHUS. EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. 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 situate 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. *Oxyguathus ornatus*, size of nature.

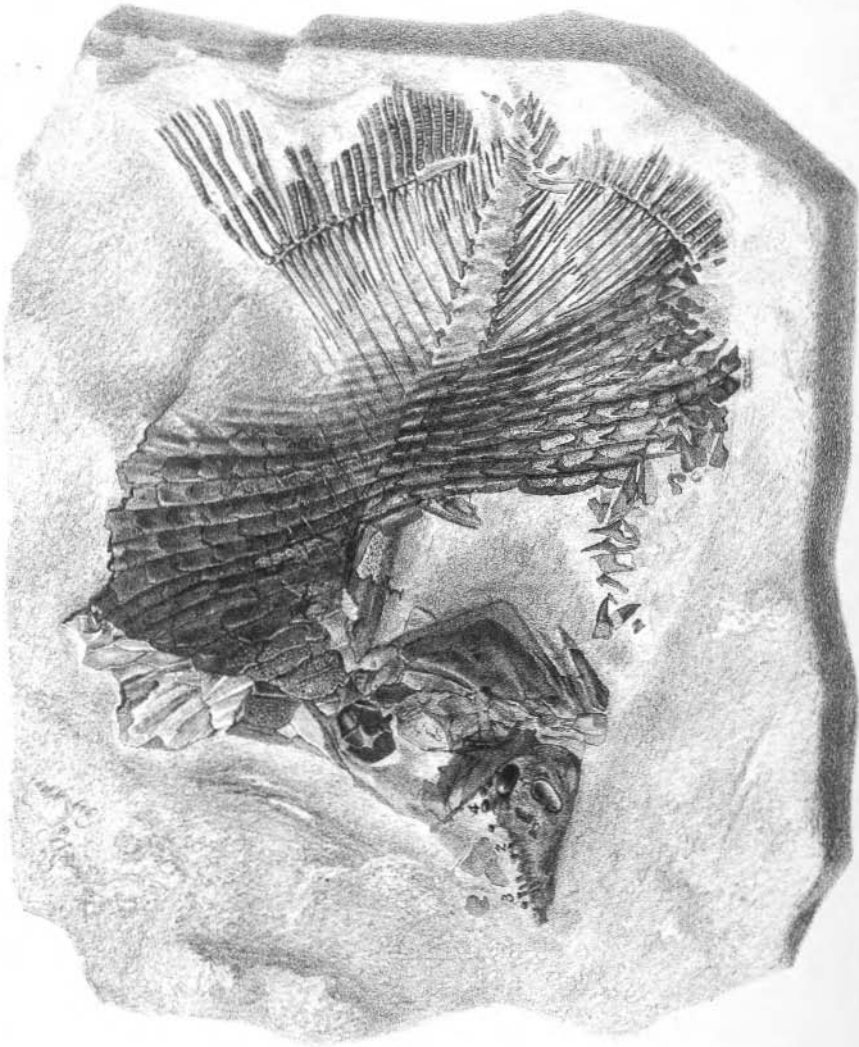
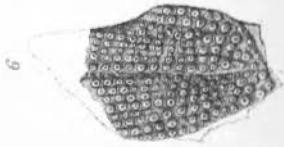
Fig. 2, 3, 4. Scales of ditto, magnified.

P. DE M. GREY EGERTON.

May 1853.

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PYCNODUS.
(Oolith)



Jos. Smith del.

PYCNODUS LIASSICUS — Egerton.

U. Porbet. Avesc.

Dark sand from the Liassic.

BRITISH FOSSILS.

DECADE VIII. PLATE X.

PYCNODUS LIASSICUS.

[Genus PYCNODUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. 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 *Gyrodi*. 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.

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.

Histionotus 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 oolitic 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.

Figures and Descriptions

ILLUSTRATIVE OF
BRITISH ORGANIC REMAINS.

DECADE IX.

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

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PREFACE.

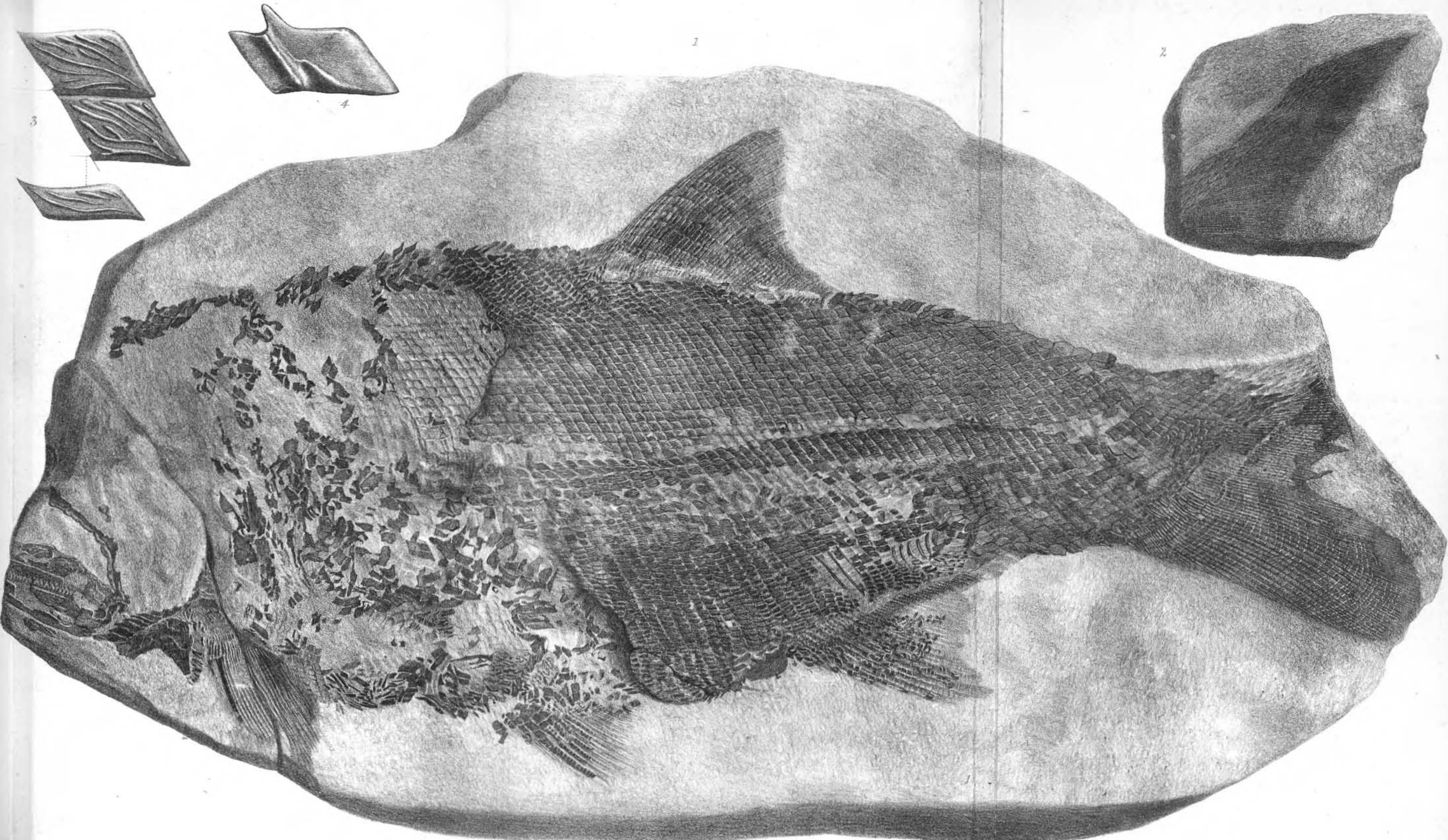
IN issuing this Decade to the Public, justice requires that I should express the great obligations of this Establishment to Sir Philip de Malpas Grey Egerton, who had previously undertaken and completed two similar works at the request of my predecessor, Sir Henry T. De la Beche.

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.



Wm. Dunker, del. et lith.

Nat. Size.

COSMOLEPIS EGERTONI.

Day & Son, Lith. & The Currier.

BRITISH FOSSILS.

DECADE IX. PLATE I.

COSMOLEPIS. GEN. NOV.

[Genus COSMOLEPIS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. 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.

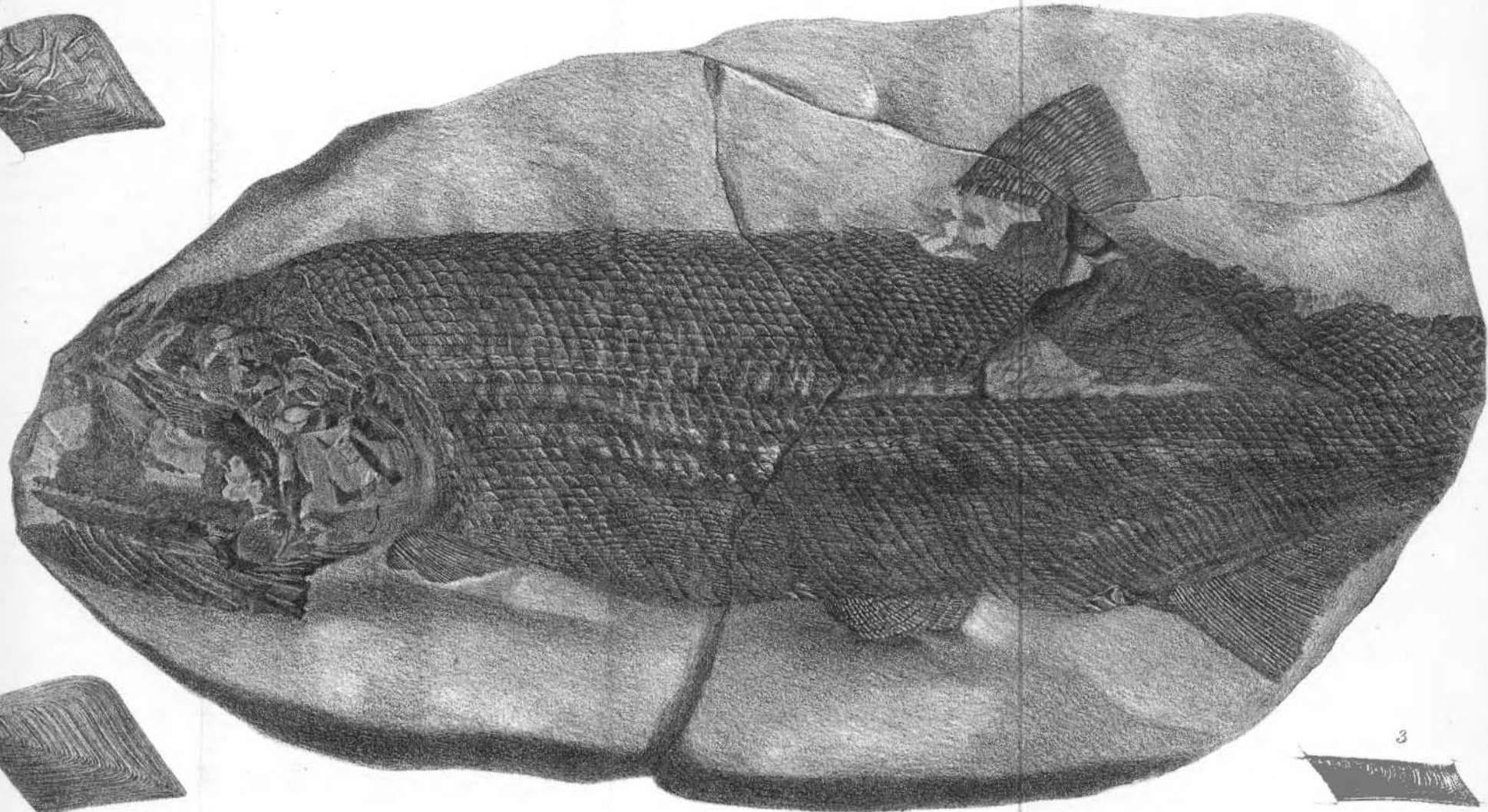
- Fig. 1. *Cosmolepis Egertoni*, size of nature.
- Fig. 2. Tail of another specimen.
- Fig. 3. Outer surface of scales, magnified.
- Fig. 4. Inner surface of scale, magnified.

February 1857.

P. DE M. GREY EGERTON.

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Joe Dinkel, del. et lith.

THRISSENOTUS COLEI *Agassiz.*

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

BRITISH FOSSILS.

DECADE IX. PLATE II.

THRISSENOTUS. GEN. NOV.

[THRISSENOTUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonialepidoti. 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 *Thrisseps*. 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 *Thrisseps*." 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 *Thrisseps*. The extended anal fin resembles that of *Sauropsis* and *Thrisseps*, 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 ganoine, 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.



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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.

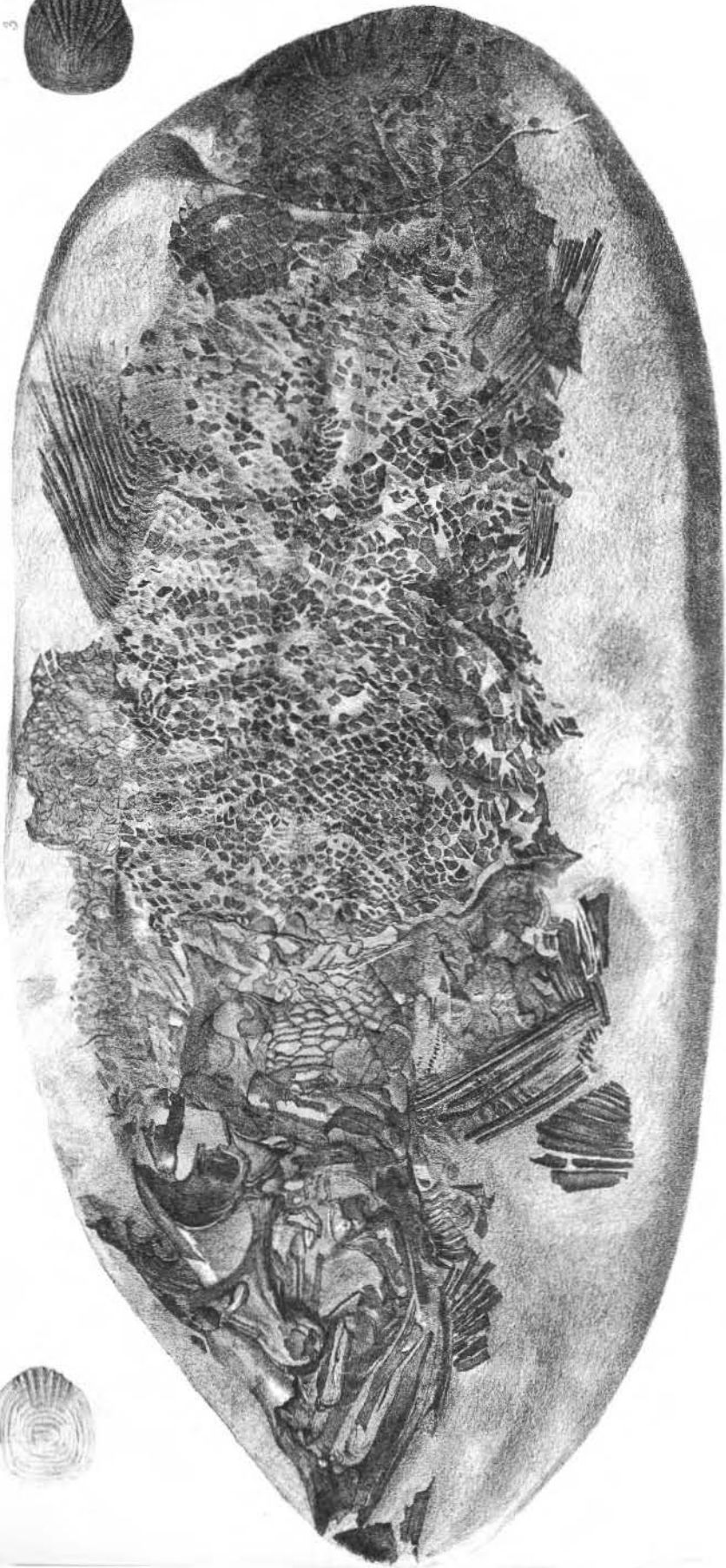
P. DE M. GREY EGERTON.

February 1857.

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ENDACTIS ACASSIZI. *Ferguson*

1847. No. 10 of the series.

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BRITISH FOSSILS.

DECADE IX. PLATE IV.

ENDACTIS. GEN. NOV.

[Genus ENDACTIS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. 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.

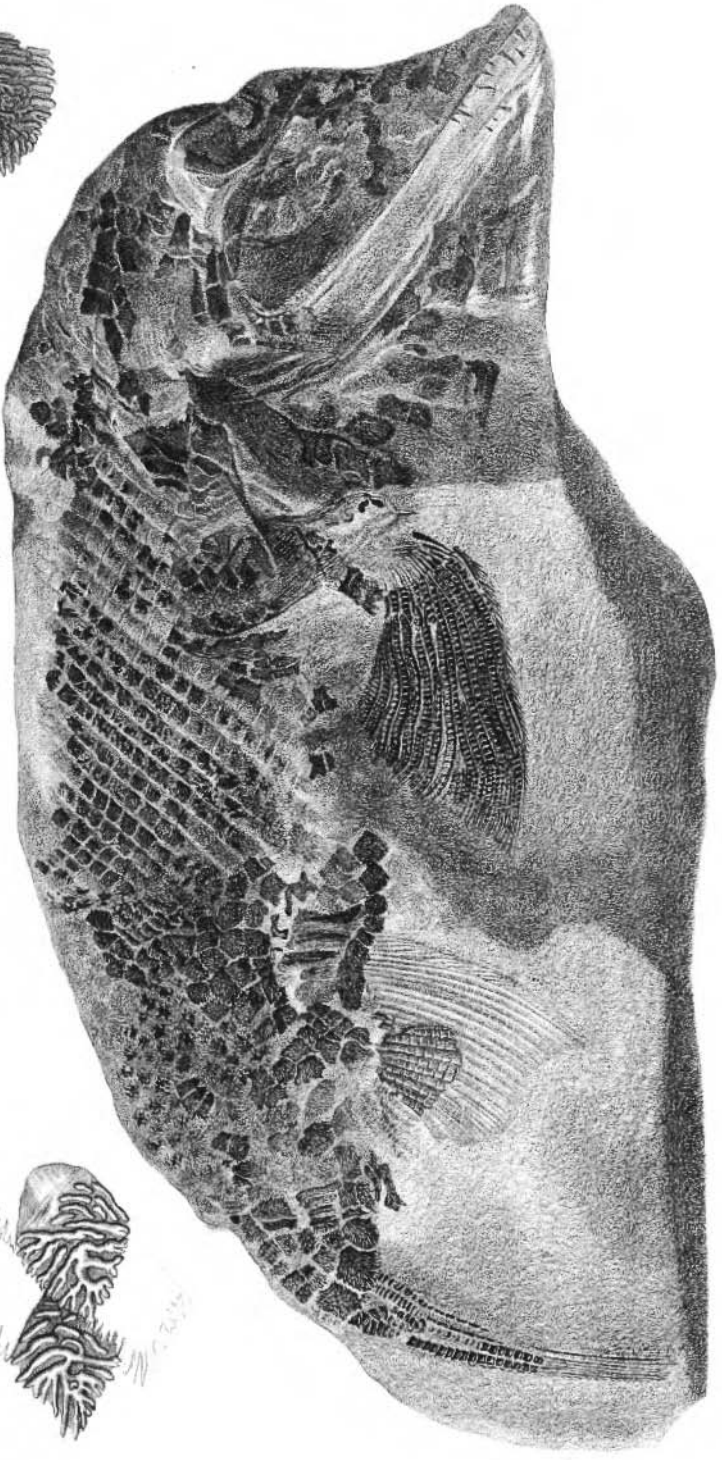
Fig. 1. *Endaetis Agassizi*, size of nature.
Figs. 2 and 3. Scales magnified, outer view.

P. DE M. GREY EGERTON.

February 1857.



1



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DECADE IX. PLATE V.

CENTROLEPIS. GEN. NOV.

[Genus CENTROLEPIS (*κεντρον, calcar*; *λεπις, 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.

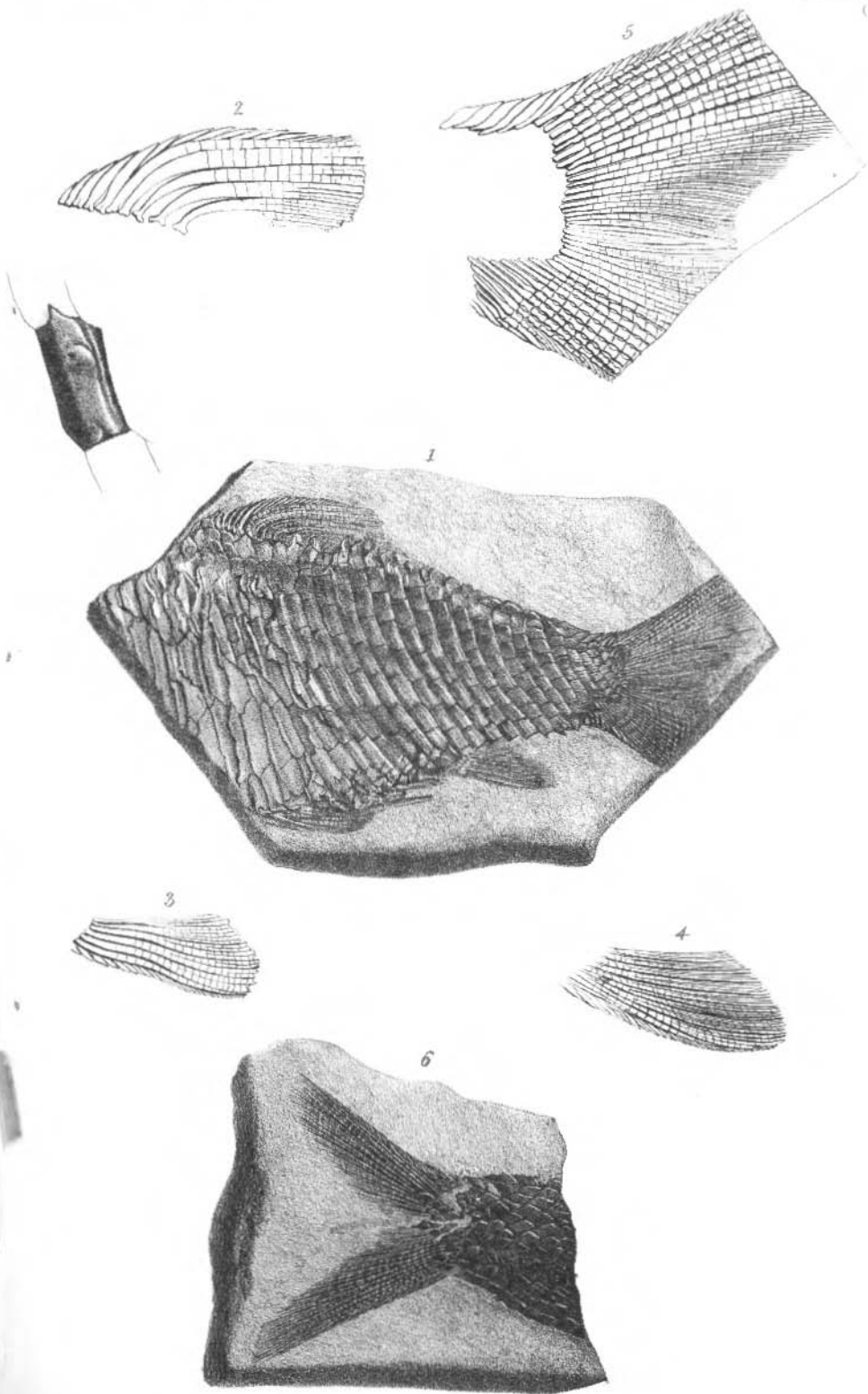
Fig. 1. *Centrolepis asper*, size of nature.

Fig. 2. Scales, magnified.

Fig. 3. Caudal scale, magnified.

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NOTHOSOMUS OCTOSTYCHIUS = *Agassiz*

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DECADE IX. PLATE VI.

NOTHOSOMUS. GEN. NOV.

[Genus NOTHOSOMUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. 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.

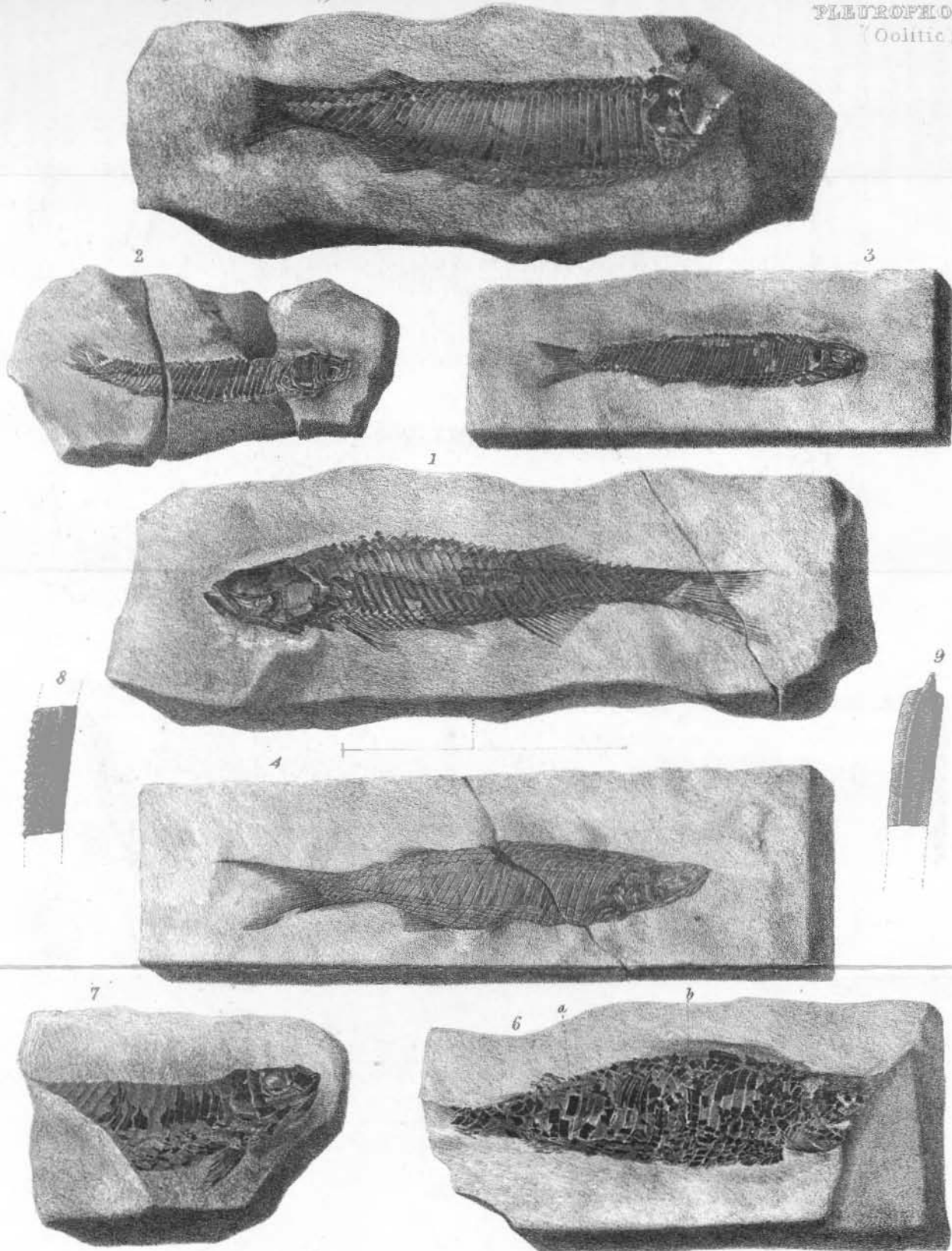
Locality.—The Lias of Street, Gloucestershire.

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.

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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 Goniolepidoti. 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 fuleral 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.

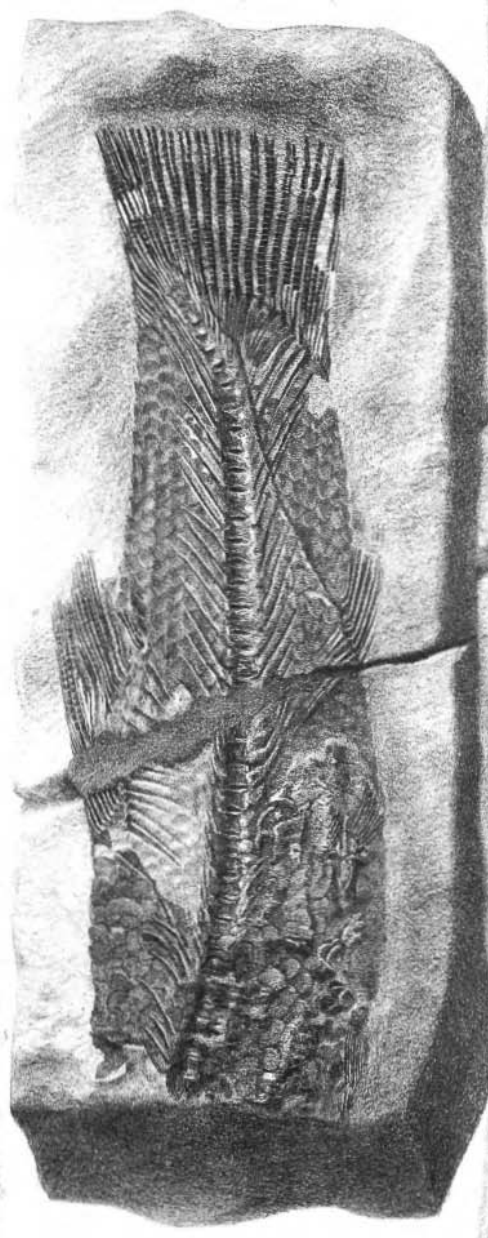
Locality.—All the specimens are from the Purbeck strata of Hartwell, near Aylesbury.

EXPLANATION OF PLATE.

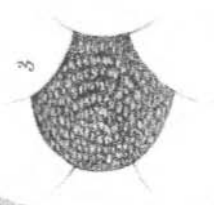
- Fig. 1. *Pleurophoils attenuatus*, magnified.
Fig. 2. *P. crassicaudus*, size of nature.
Fig. 3. *P. levissimus*, size of nature.
Fig. 4. *P. longicaudus*, size of nature.
Fig. 5. *P. serratus*, size of nature.
Fig. 6. *P. serratus*, size of nature.
Fig. 7. *P. serratus*, size of nature.
Fig. 8. Scale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

P. DE M. GREY EGERTON.

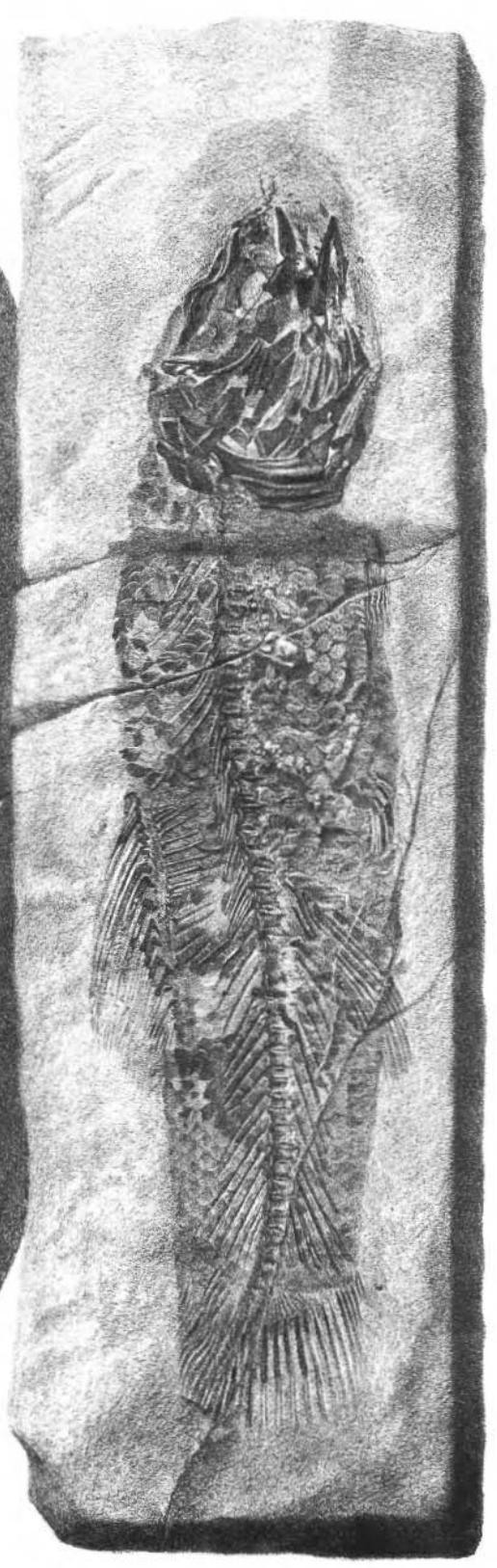
February 1857.



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2



MEGALURUS DAMONI. Egerton.

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BRITISH FOSSILS.

DECADE IX. PLATE VIII.

MEGALURUS DAMONI.

[Genus MEGALURUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Gonirolepidoti. Family Sauroidei. Sub-family Sauroidei homocerici. 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 *Pachycornus* 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 vertebræ. 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 *Cælacanthus*. 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.

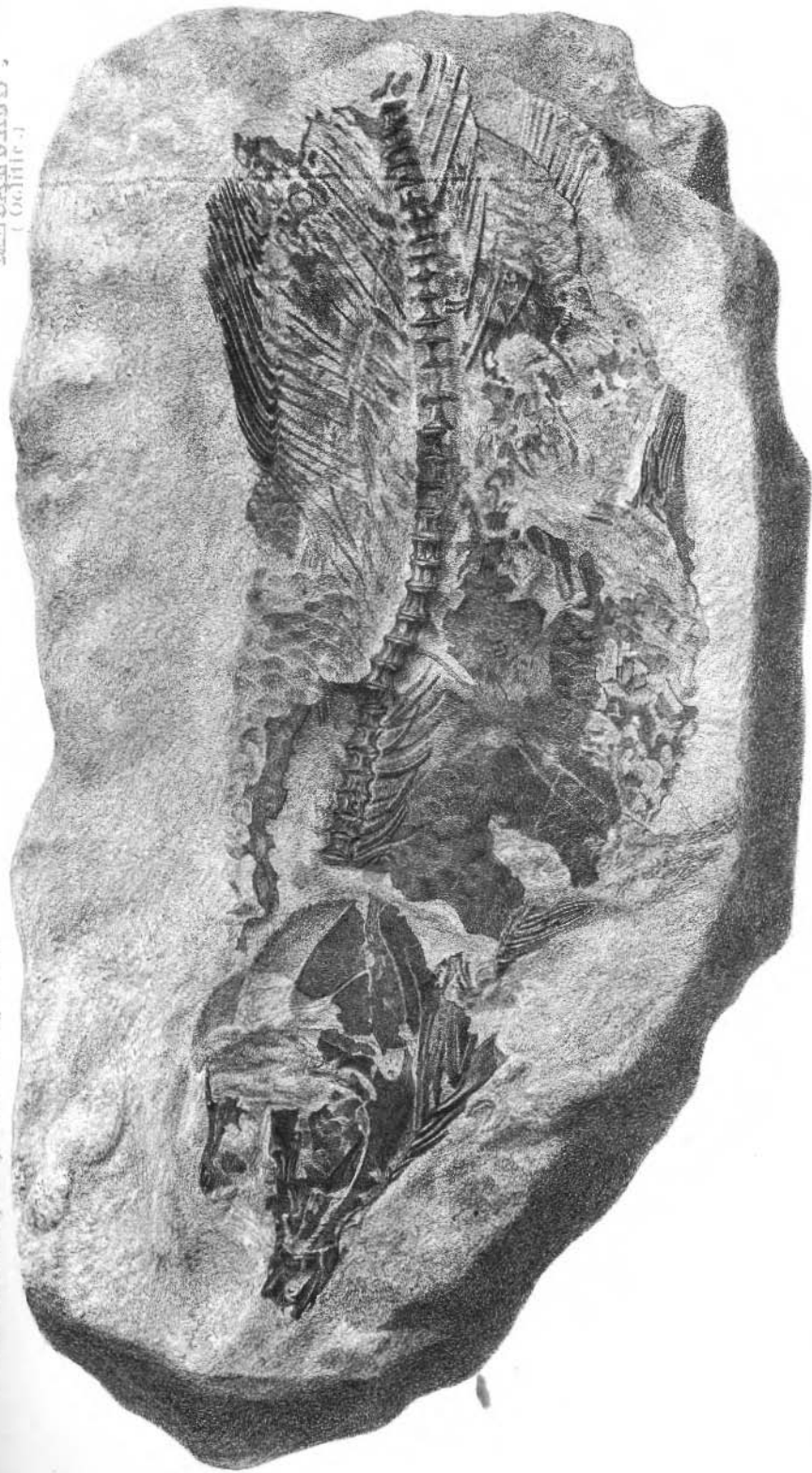
Fig. 1. *Megalurus Damoni*, size of nature.

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

Fig. 3. Scale, magnified.

P. DE M. GREY EGERTON.

February 1857



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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.

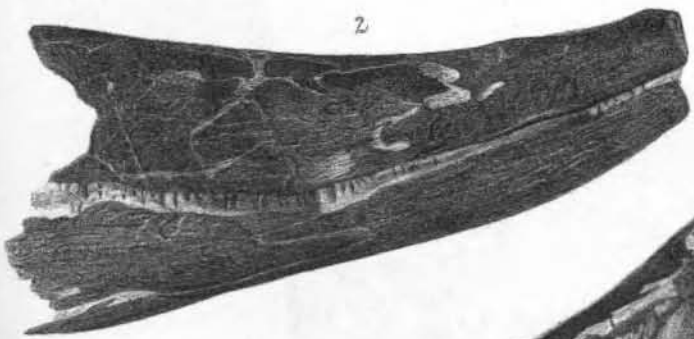
Locality.—The specimen figured and described was found in a quarry of Purbeck stone in the neighbourhood of Swanage, and is now in my possession.

DESCRIPTION OF PLATE 9.

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

P. DE M. GREY EGERTON.

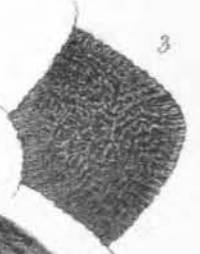
April 20, 1857.



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MACROPOMA ÉGERTONI. Agassiz.

BRITISH FOSSILS.

DECADE IX. PLATE X.

MACROPOMA EGERTONI.

[Genus MACROPOMA. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolenipidoti. Family Cœlacanthi.) 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 denticerous.]

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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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.

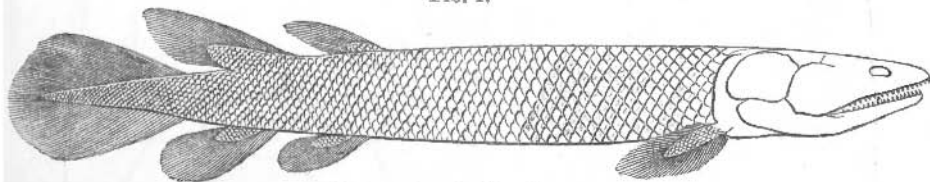
## DECADE THE TENTH.

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.\*

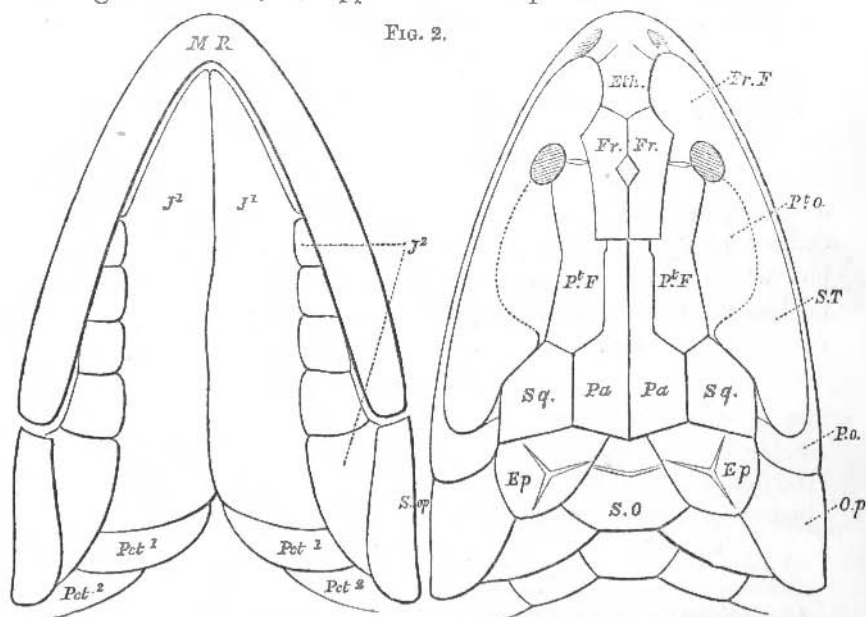


Diagram of the Head of *Glyptolemus*.—For an explanation of the letters, see p. 40.

\* 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."

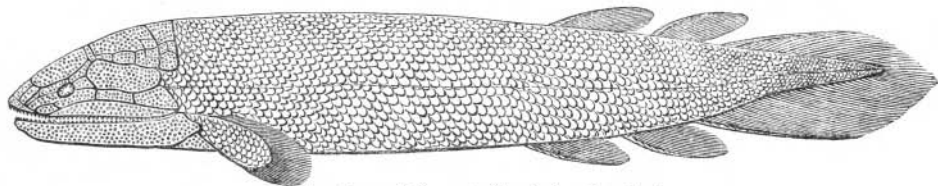
The pectoral arch is covered by two triangular, sculptured, osseous plates (Pct<sup>1</sup>, Pct<sup>2</sup>), which meet in the middle line below and are superficial to the so-called coracoids. The paired, or pectoral and ventral, fins are lobate; that is, the fin has a central axis, or stem, covered 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 diphycceral, 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 *Glyptolæmus*, 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 Saurodipterinen, 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 *Glyptolæmus* (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 *Glyptolæmus*. Pander, however, makes no

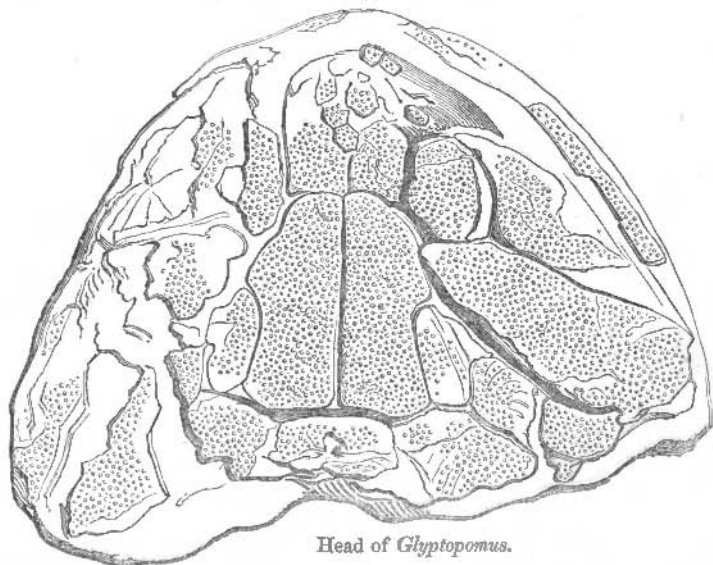
\* I have endeavoured to show elsewhere (Quarterly Journal of Microscopical Science, Oct. 1858) that the so-called "homocercal" *Teleostei* of the present epoch are in reality excessively heterocercal; but the word "homocercal" is now so generally understood to signify a tail like that of most existing *Teleostei*, that I prefer to employ Prof. M'Coy's term "diphycceral" 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.

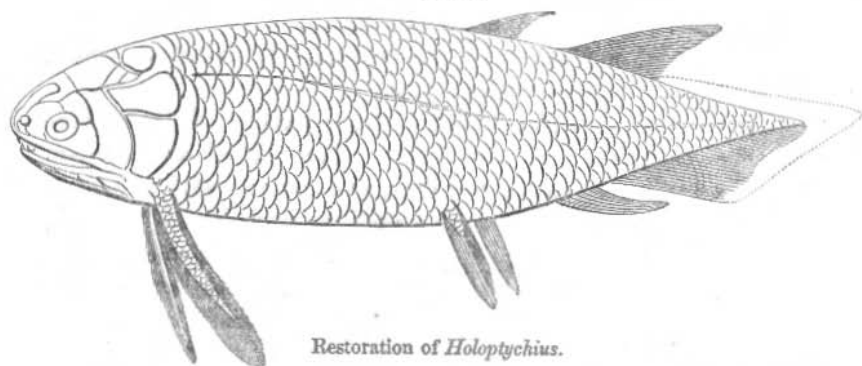
Head of *Glyptopomus*.

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 *Crocodylia*.

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 diphyrcercal 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 "Célacanthes," 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 "Célocanthes 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 2a 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 *Gyroptychius*, 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*.

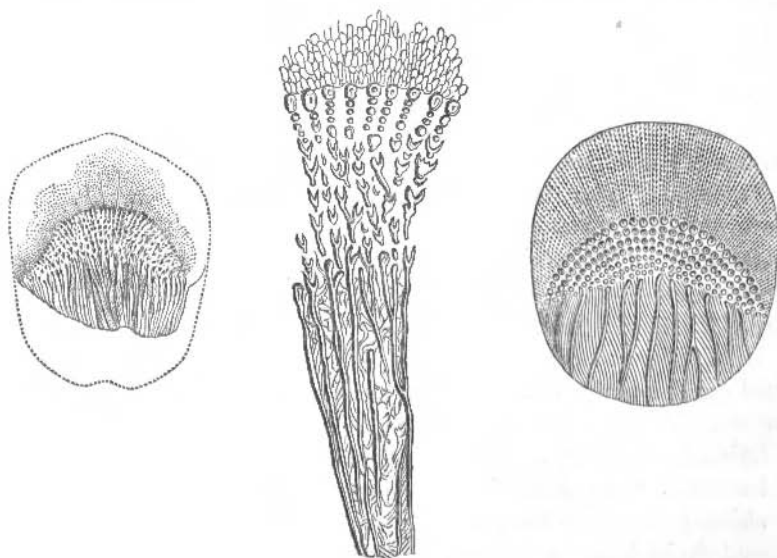
The scales are, in general, rounded, sometimes circular, sometimes oval, sometimes more or less quadrate, by reason of the less rounding off of their angles. They overlap in different degrees, and their external sculpture is different in different parts of the body, whence arises such an amount of unlikeness,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

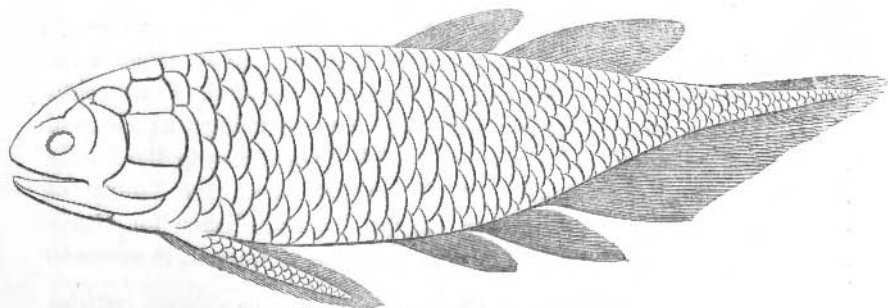


There can be no doubt that the scales of *Glyptolepis* possess the ornamentation here represented. Not only does Professor Pander positively state that the scale figured by him was worked out from a Lethen Bar nodule, and formed part of the unquestionable *Glyptolepis* represented in his Plate 7, fig. 4; 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

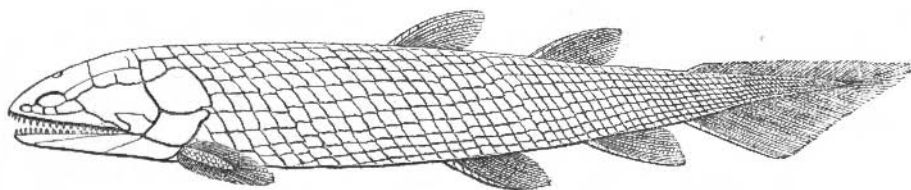
\* It may be that the ventral fins are lobate, but I have seen no specimen justifying that conclusion.

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 *Gyropterychius*, though undoubtedly related to it.

The resemblances which obtain between *Gyropterychius*, 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 *Glyptolemus*. 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 *Glyptolepis*. 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 *Glyptolemus*, 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 Saurodipteridae 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 museau est " élégamment échancré au milieu et renflé en un bec, très 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.

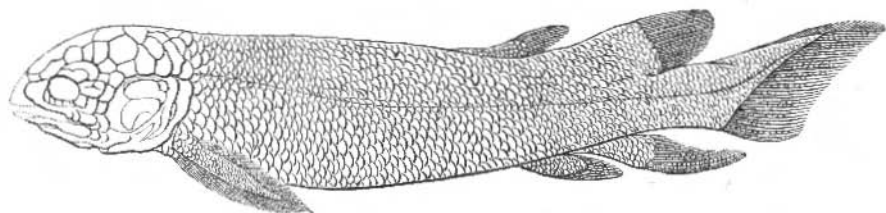
The Saurodipterini and Glyptodipterini being thus separated from other Palæozoic fishes, as well-defined families, perfectly distinct from one another, though closely allied by the community of characters displayed in the number, structure and disposition, of their fins, the absence of branchiostegal 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 CTENODIPTERINI, 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. .

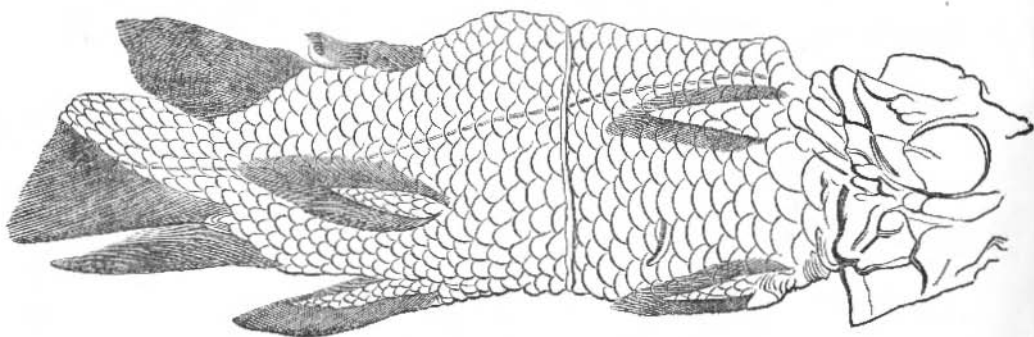
dipterini, seeing that it possesses all those structural peculiarities which are common to these two families. In fact, as Hugh Miller\* originally pointed out in successive notices, *Dipterus* has the dorsal

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 ankylosed 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 *Cœlacanths* 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 *Cœlacanths*, 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* (*miki*) 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 '*Cœlacanths*'), 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 *Platygnathus* 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 "Cœlacanthus;" 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.

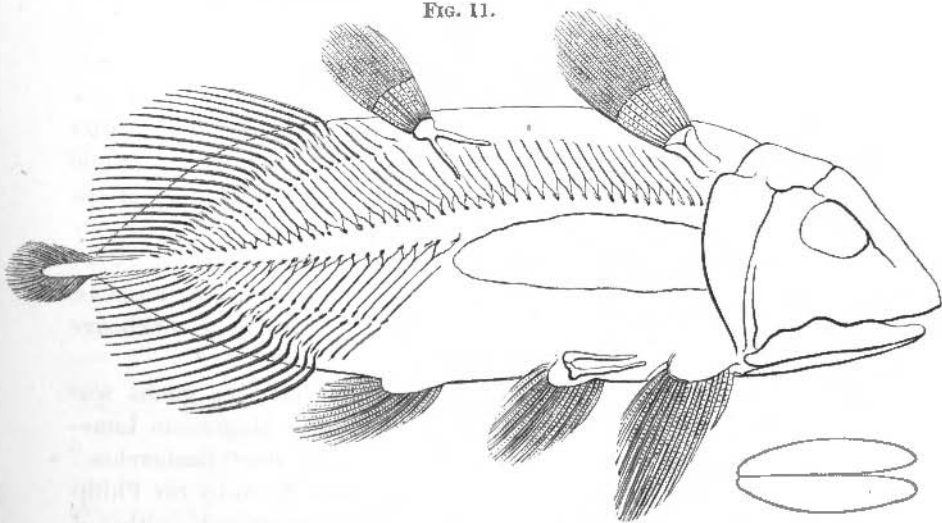
But first, what are the characters of the genus *Cœlacanthus*? This question is by no means so easily to be answered as might be imagined, but the following facts appear to furnish a conclusive reply to it.

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.

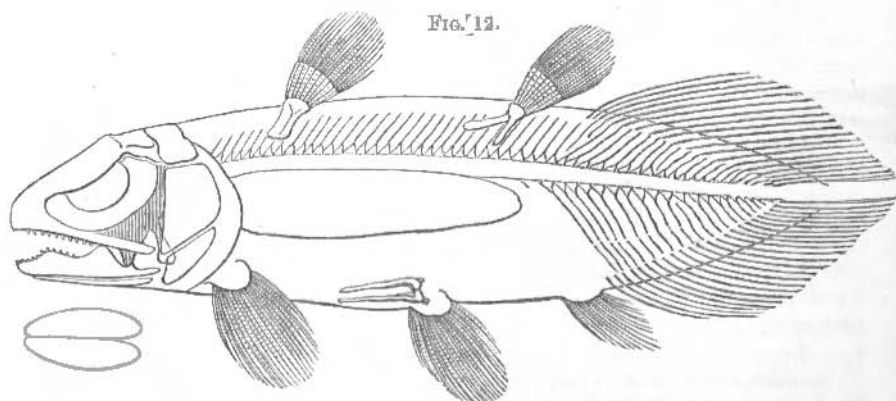


Restoration of *Undina*. (Partly after Münster, partly from Lord Enniskillen's specimen. Below the head are the contours of the jugular plates.)

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, "*Caelacanthus*" *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 *Caelacanthus* enumerated by Agassiz, and I can therefore say nothing about them. But *Caelacanthus caudalis* (Egerton) is a true Caelacanth, 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 *Caelacanthus* 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 *Coelacanthus* 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 neurapophysis. A small supplemental fin extends an inch beyond the larger caudal fin, as in *Undina* and *Coelacanthus*. 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 *Coelacanthus*, 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*, *Coelacanthus*, 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.

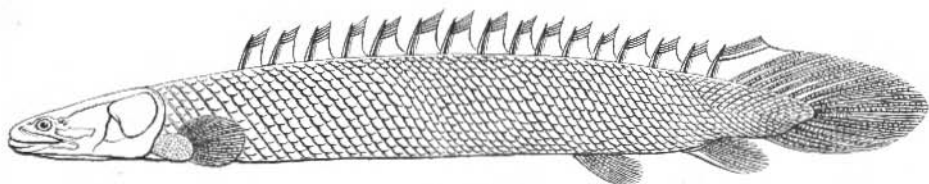
Their special affinities among these three families appear to me to lie chiefly with the Ctenododipterini: the scales, the arrangement of the teeth, and the form of the lower jaw in the two families presenting many curious analogies.

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 diphyccercal.\*

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 K lliker, "Ueber das Ende der Wirbels ule 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 merkwurdig zu sehen wie *Polypterus* so ganz in den Hintergrund gestellt wird, Herr J. M ller (Ueber d. Bau.) sagt ausdr cklich 'Fur den *Polypterus* kenne ich unter allen fossilen Ganoiden keine analogie.' Und Herr Pictet wiederholt dasselbe gleichfalls, 'aucun fossile n'a  t  rapproch  de ce genre remarquable.' Wir werden in Zukunft sehen dass wenn man  berhaupt 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 Knochenplatten und die Stelle der Kiemenhautstrahlen, durch den Bau der Kopfknochen, u.s.w., eine gr ssere 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.



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.

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.

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

*Cœlacanthus*, *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.

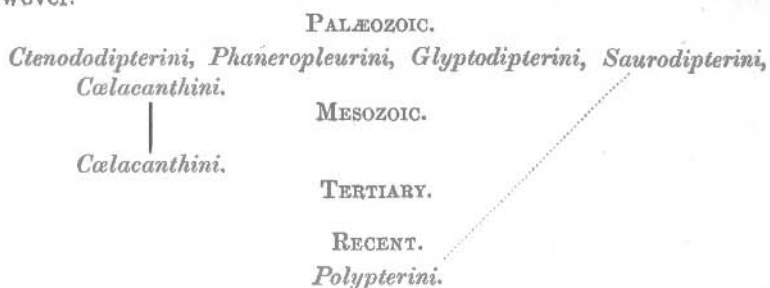
The characters of five of the six families which compose this suborder have been given, incidentally, in the preceding pages, but the table contains another family whose collocation with the rest requires justification.

\* κροσσωτῶδες, πτέρυξ, "fringed fin." "Crossopterygida" 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, Ctenododipterine, Phaneropleurine, and Cœlacanth Crossopterygidæ. *Lepidosiren*

FIG. 18.

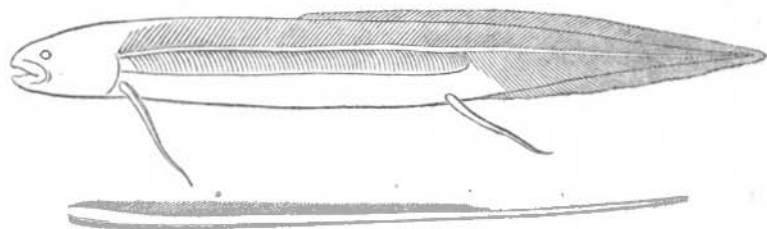


Diagram of *Lepidosiren*. (The lower figure represents the pectoral fin on a larger scale.)

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 *Phaneropleuron*, 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 *Phaneropleuron*, 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 Cœlacanth 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 Crossopterygidæ, 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 Crossopterygidæ, 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 Crossopterygidæ, 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*, *Phaneropleuron*, *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.

Heterocerical 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 heteroclit 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.

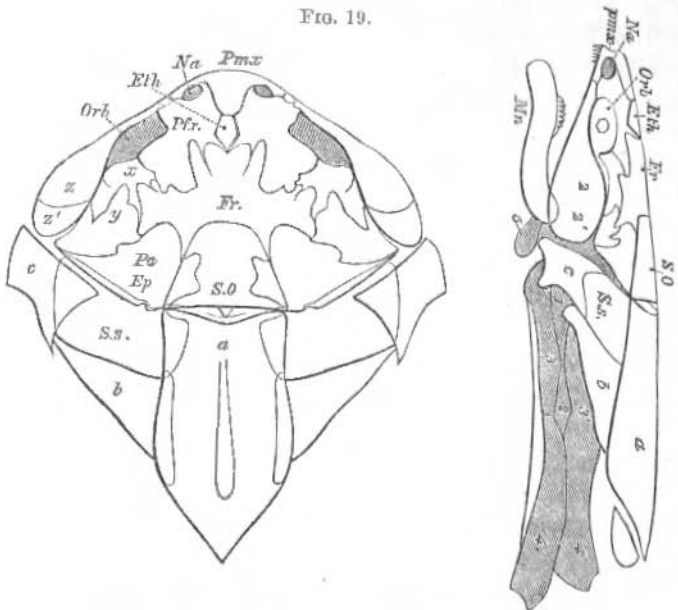
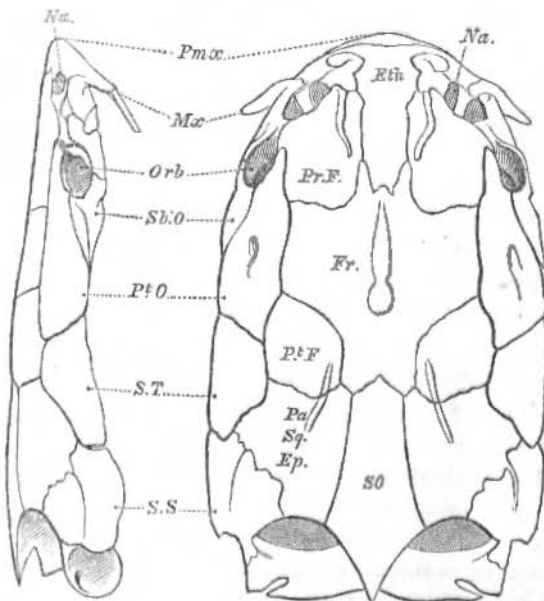
Bones of the head and of the cuirass of *Coccosteus*.

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.

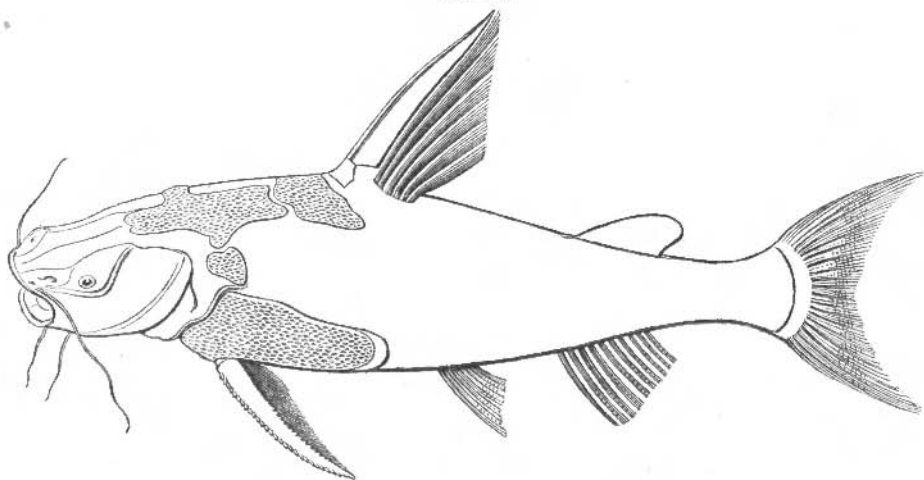
In fig. 20 a careful, reduced representation of the top of the skull of this fish is given, and it will be seen, that in everything but the minor details of form, it agrees with *Coccosteus*. The middle line of the skull is, as in the latter genus, occupied by three bones. S.O., the supra-occipital, 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.

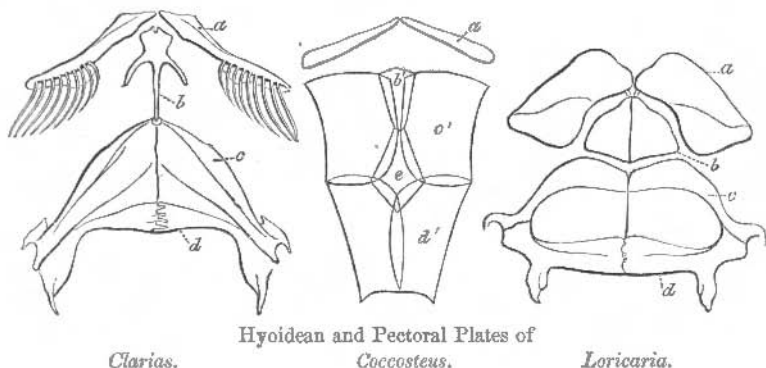
*Arius rita*, after Cuvier and Valenciennes.

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 suprascapula, 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 primordially 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 Crossopterygian 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 Ctenodipterini and Coelacanthini.

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>Prmx.</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.]

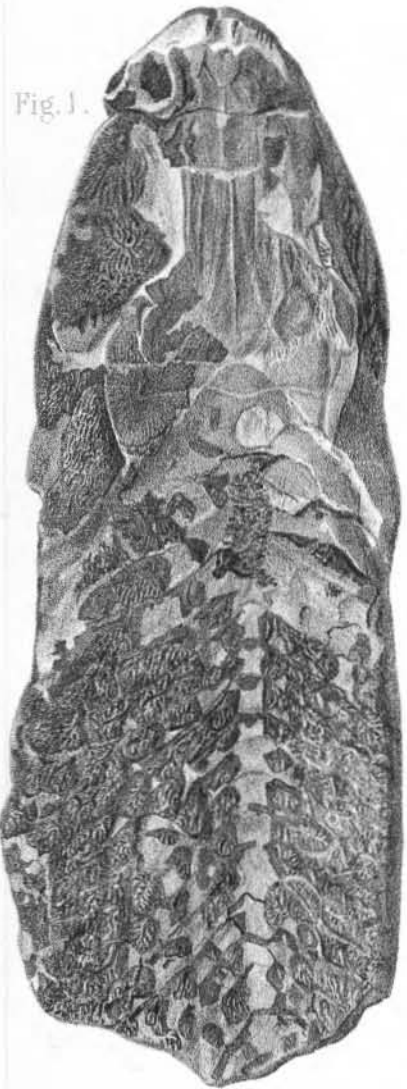


Fig. 1<sup>a</sup>



Fig. 2.

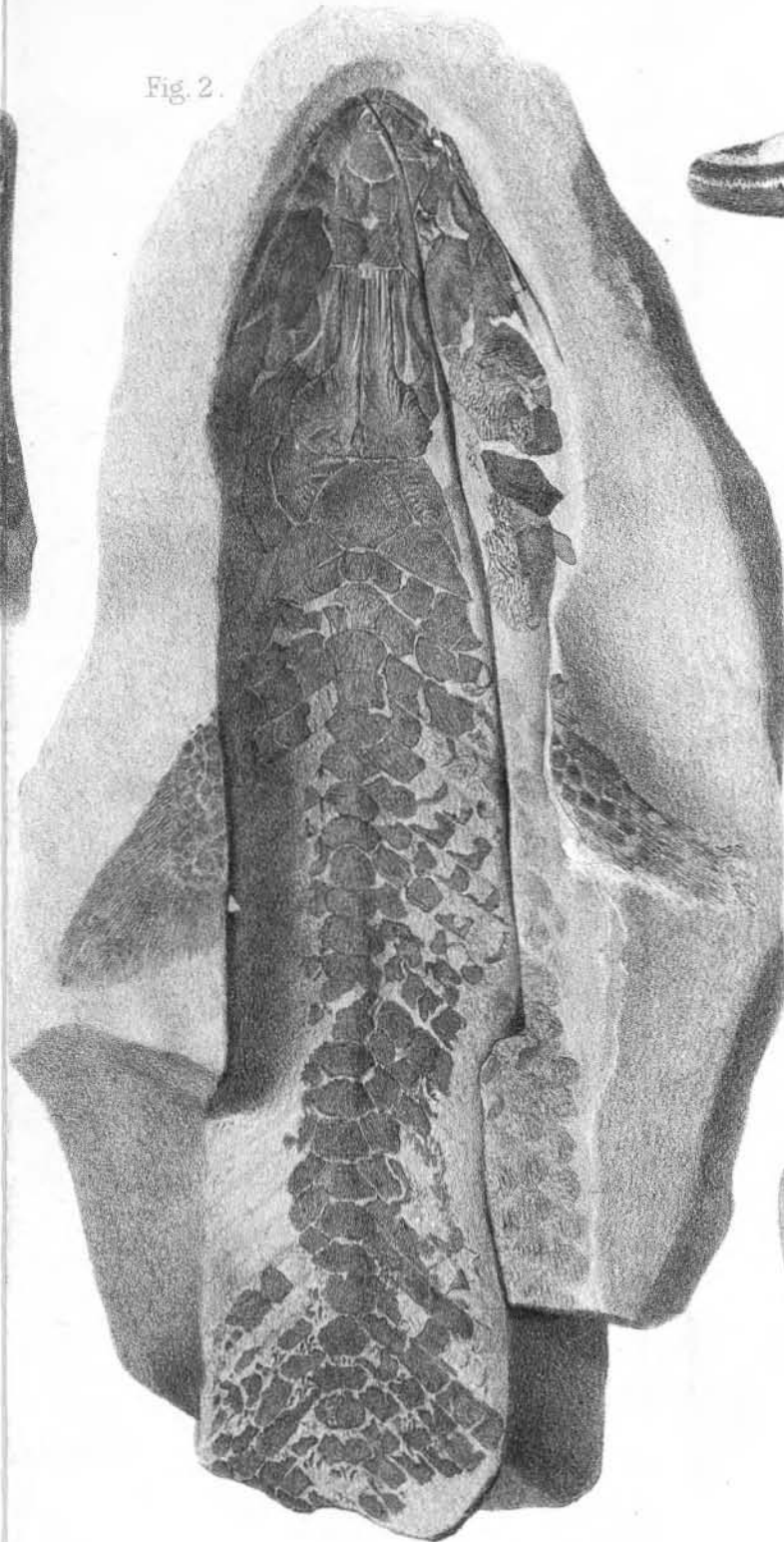


Fig. 1<sup>b</sup>



Fig. 1<sup>c</sup>



Fig. 5.



Fig. 4.

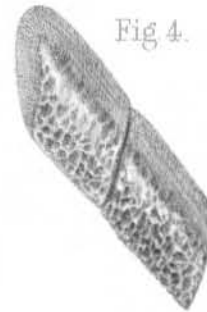


Fig. 3.

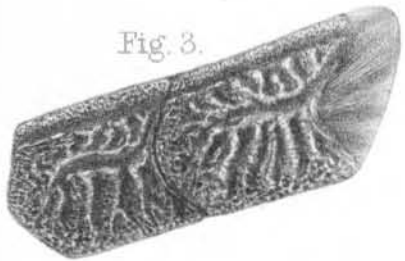




Fig 1.

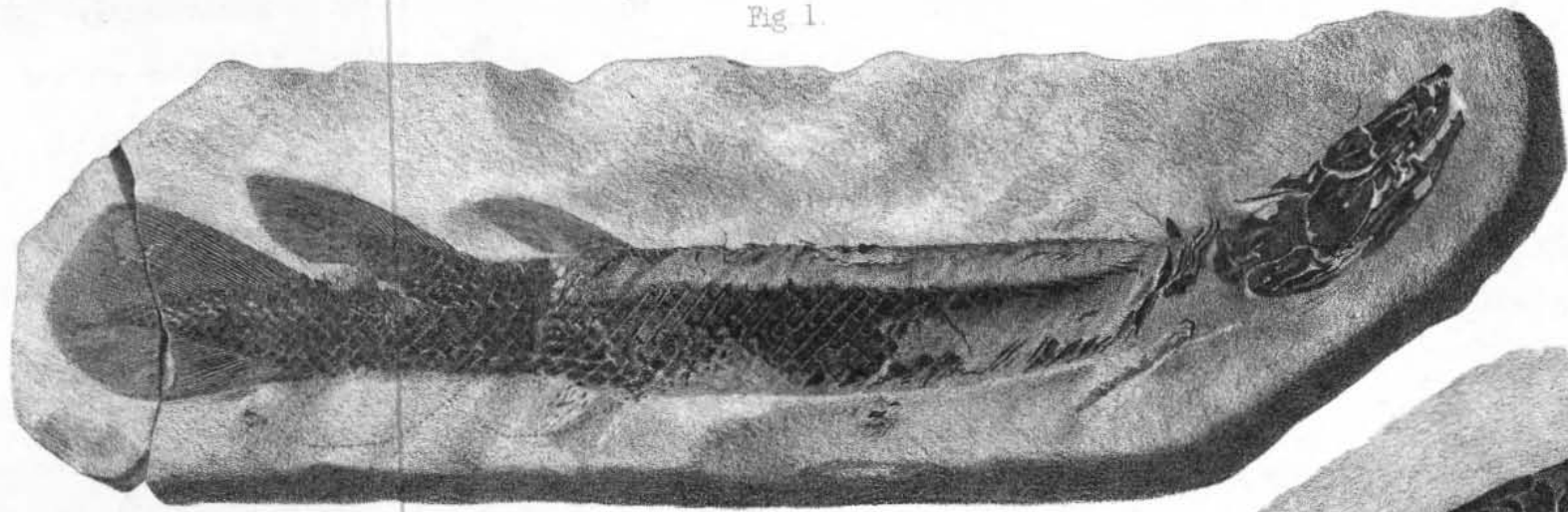


Fig 1<sup>a</sup>

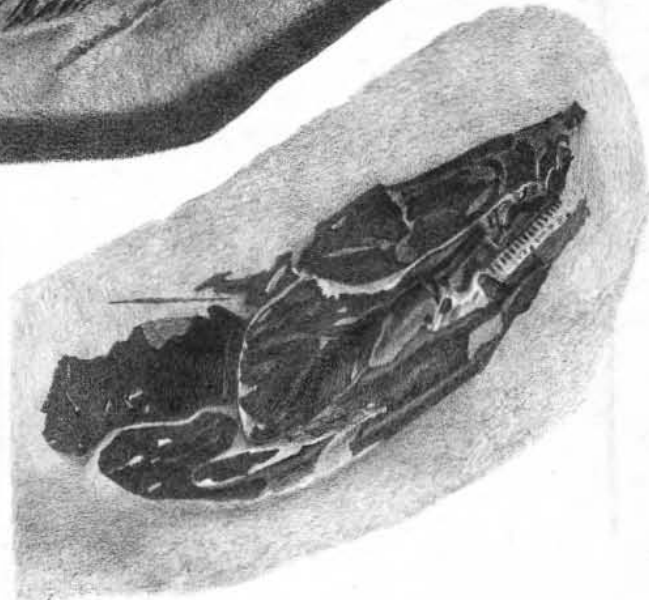


Fig 2.



Fig 4.

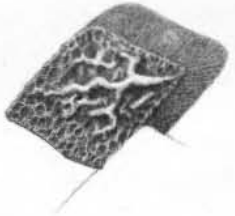
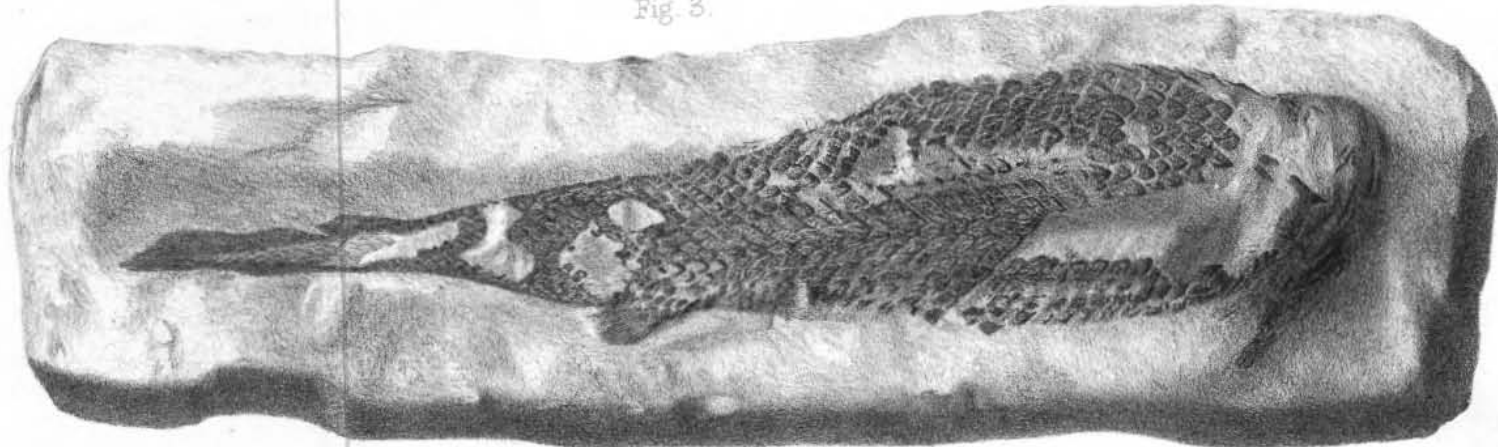


Fig 3.



GLYPTOLÆMUS KINNAIRDI — *Huxley.*





# BRITISH FOSSILS.

## DECADE X. PLATES I. AND II.

### 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 *Glyptolemus*, 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-quadrangle 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 *Glyptolemus*, 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.

*Glyptolemus* 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 *Glyptolemus 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 *Glyptolemus 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. II. HUXLEY.



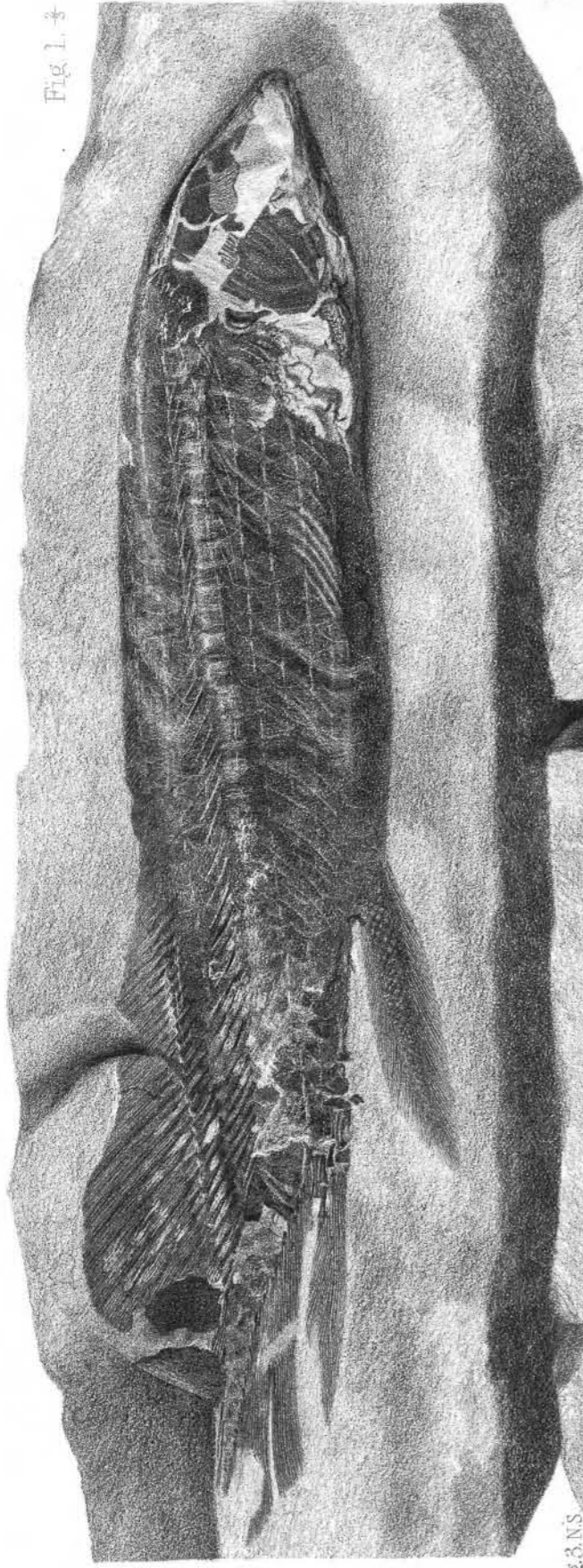


Fig. 1.  $\frac{3}{4}$

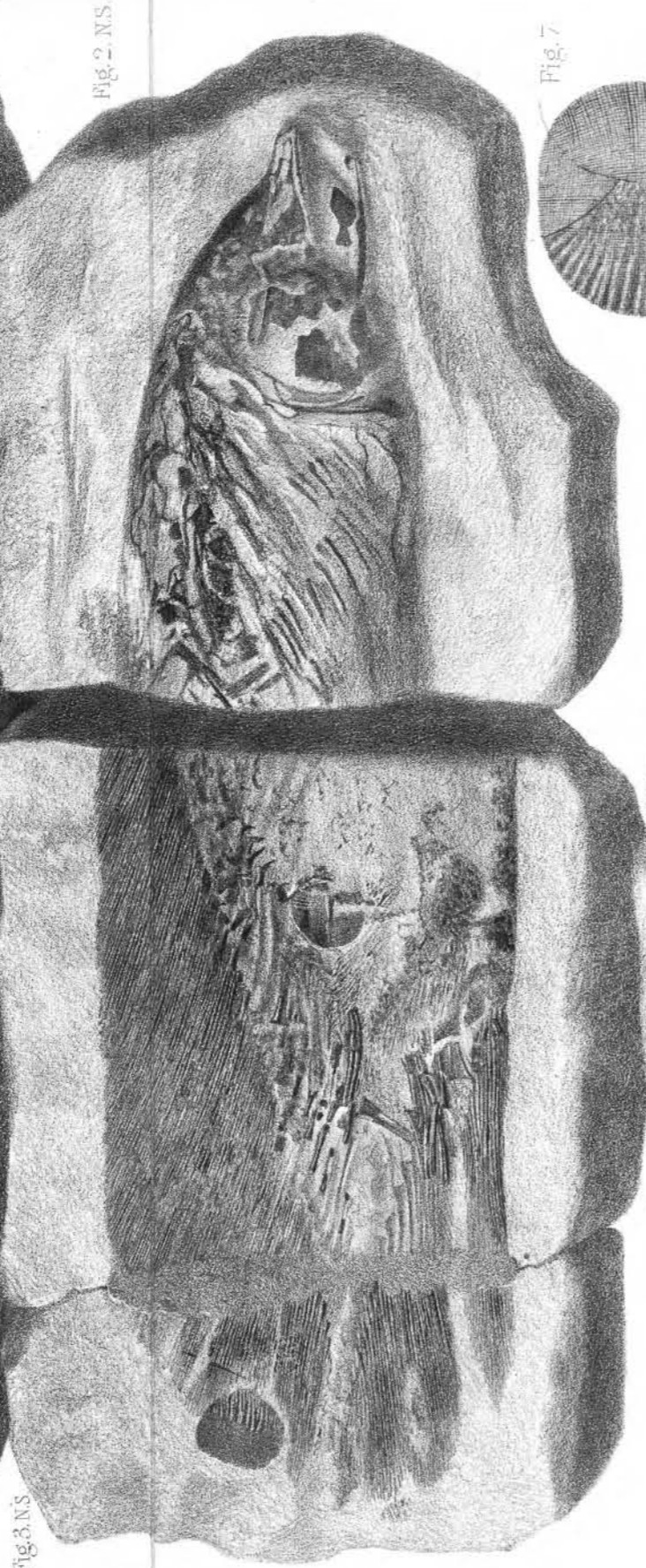


Fig. 2. N.S.

Fig. 3. N.S.

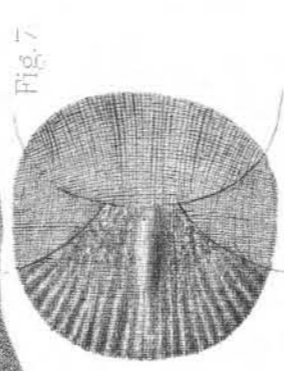
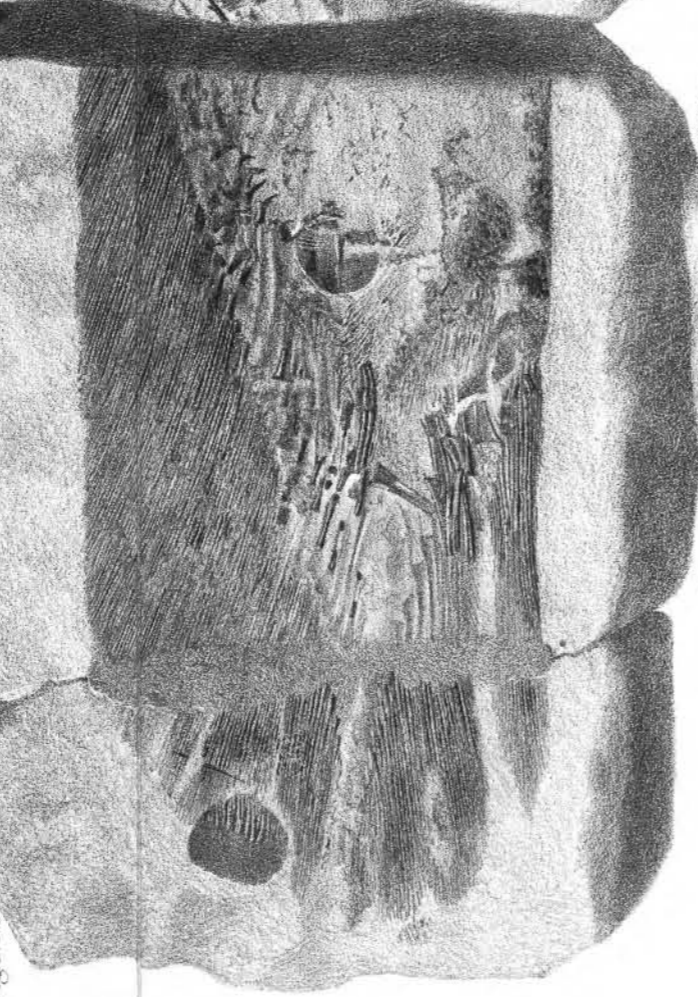


Fig. 7.

Fig. 6. *R.A.*

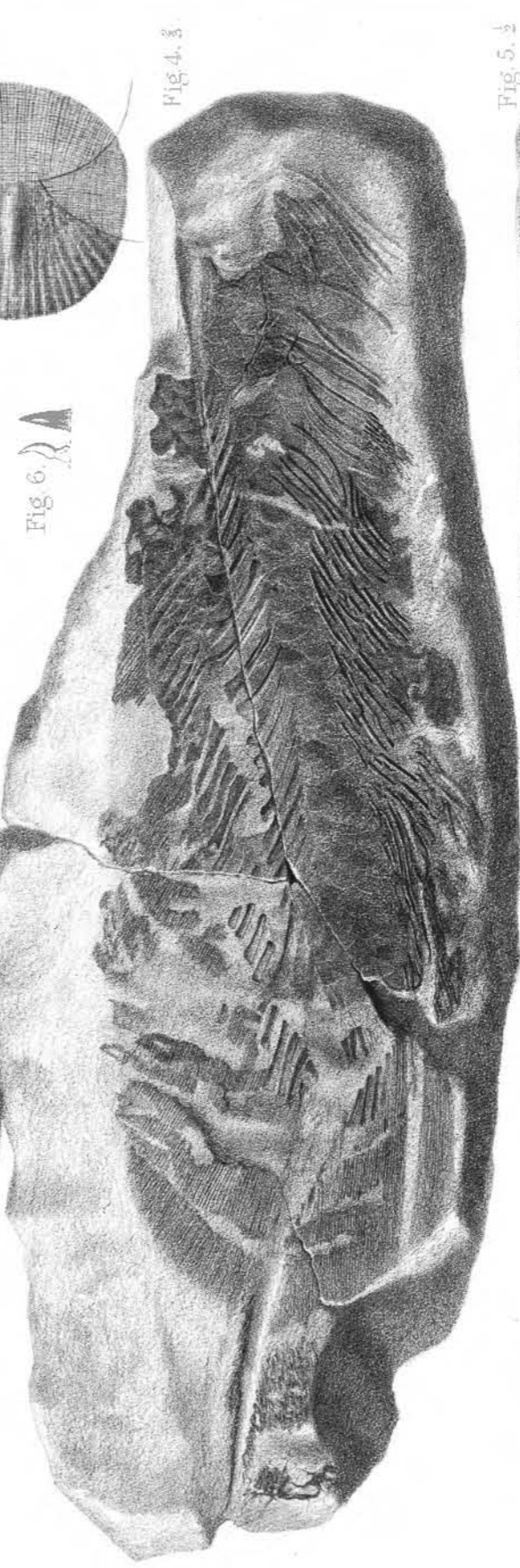


Fig. 4.  $\frac{3}{4}$

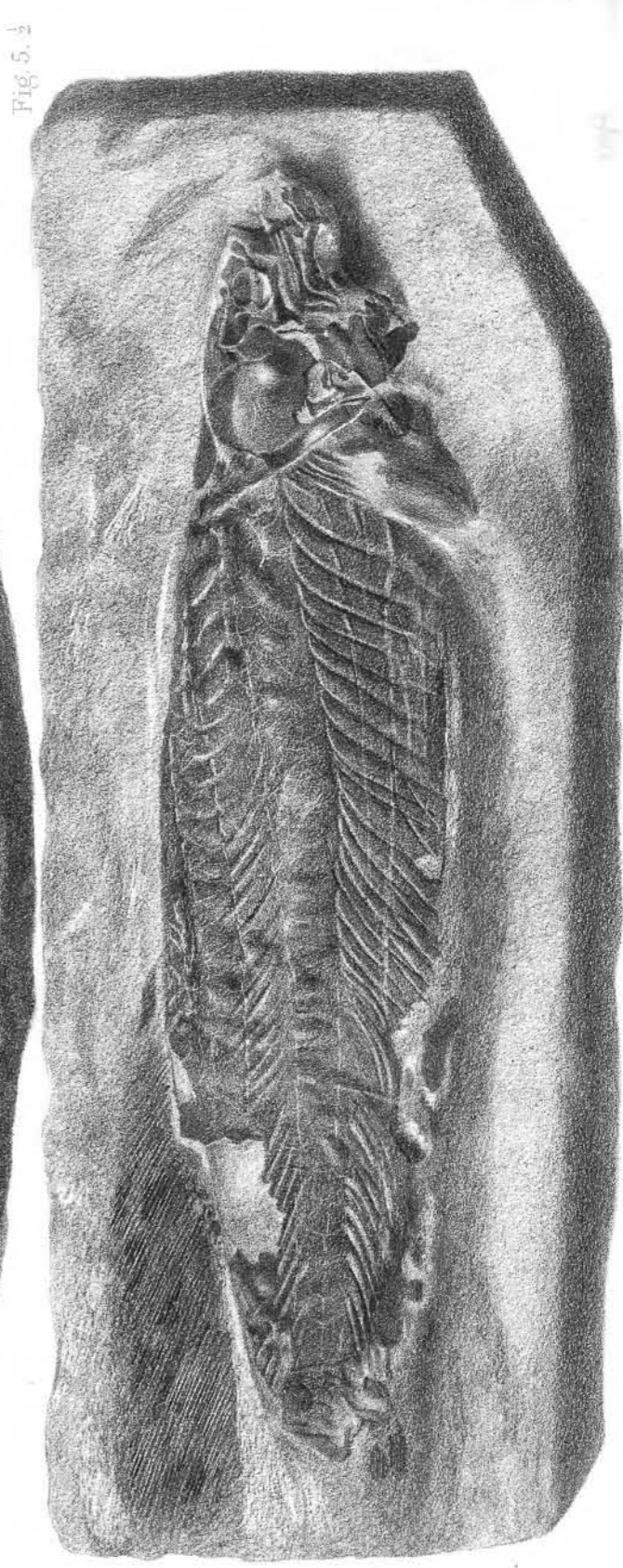


Fig. 5.  $\frac{1}{2}$





# BRITISH FOSSILS.

## DECADE X. PLATE III.

### PHANEROPLEURON ANDERSONI.

[Genus PHANEROPLEURON. HUXLEY. (Sub-kingdom Vertebrata. Class Pisces. Order Ganoidei. Sub-order Crossopterygida. 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.

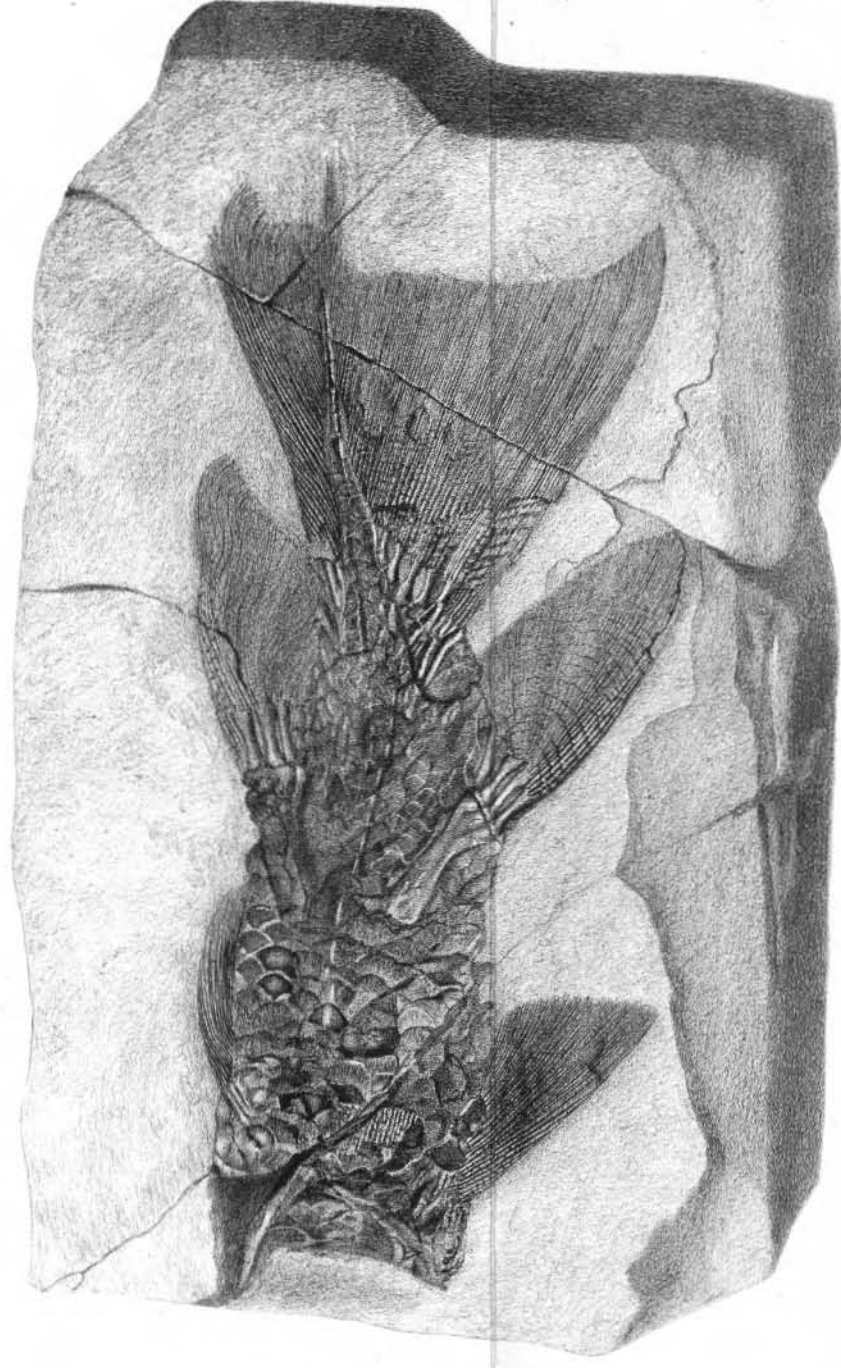
T. II. HUXLEY.

*Jermyn Street, Nov. 1, 1861.*



TRISTICHOPTERUS.  
(Devonian.)

1



3

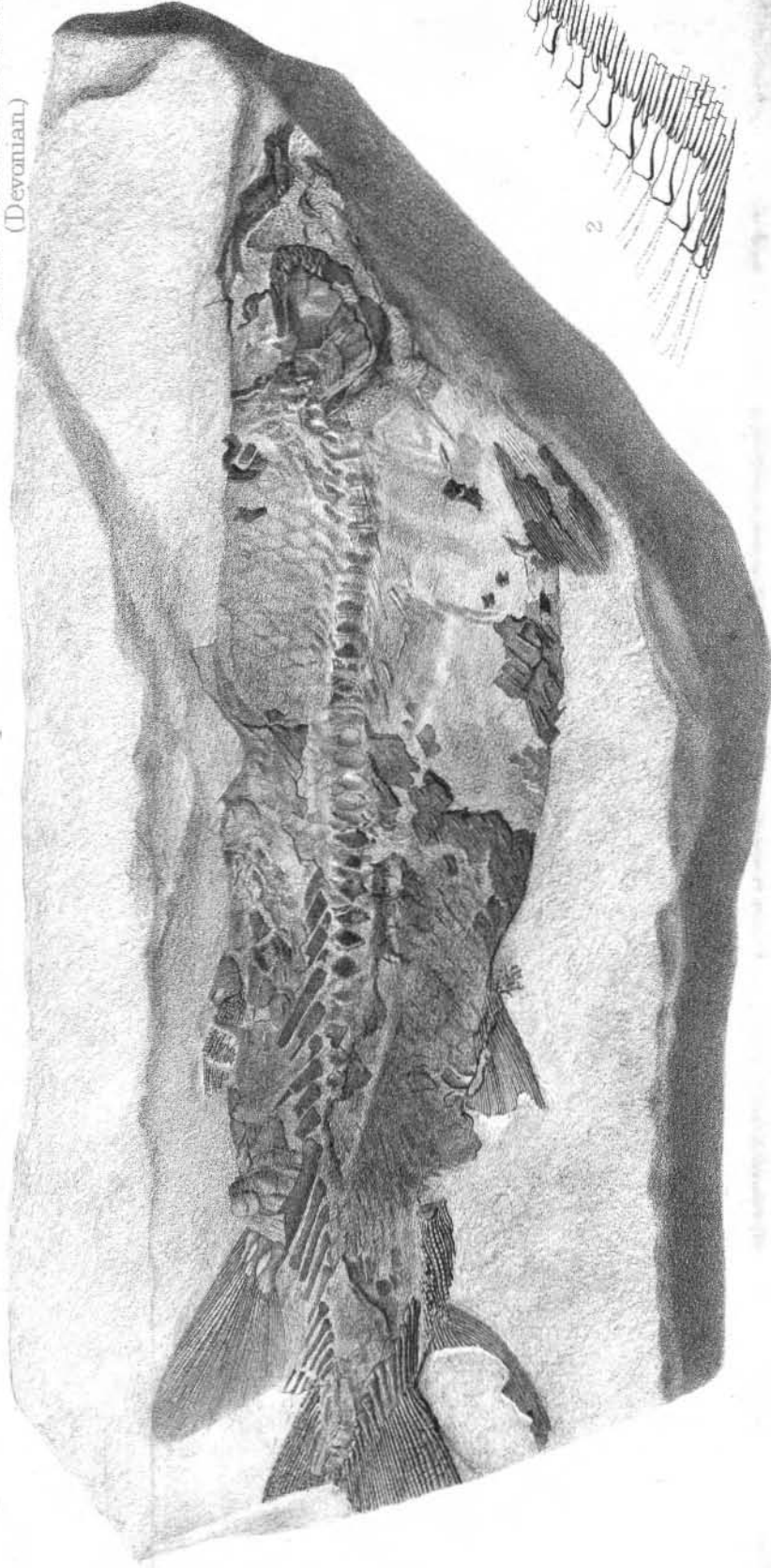


2



DECADE X. PL. 4.  
TRISTICHOPTERUS.  
(Devonian.)

1



2





# 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 Goniopodoti. 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 *Sauroidi-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, στήλη series, πτερὸν 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. McCoy, 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 Coelacanthoid family, I have been mainly influenced by its resemblance in many respects to *Dipterus*. The latter genus was arranged by Professor Agassiz with the *Sauroides-dipterini*, but I have long ago seen sufficient reasons for considering it a Coelacanth, 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 *Ctenodo-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.

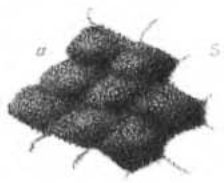
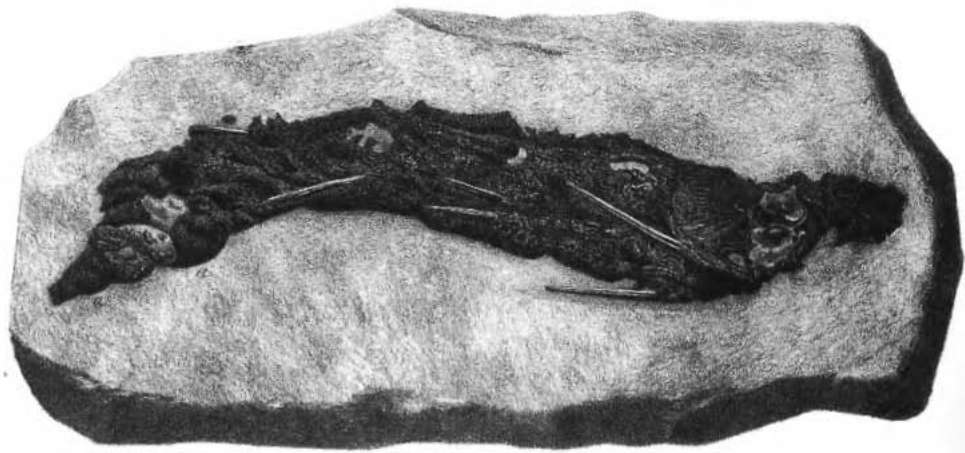
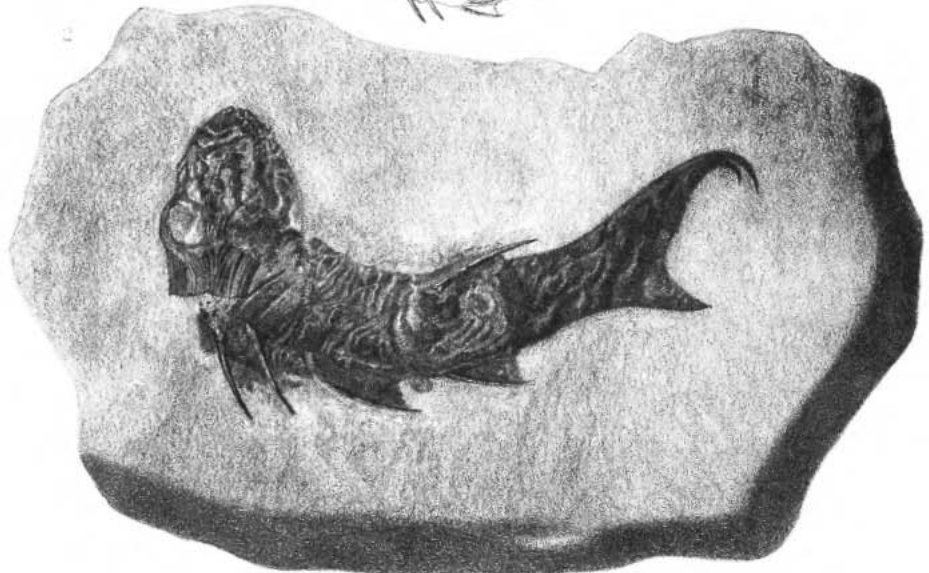
- Fig. 1. *Tristichopterus alatus*, size of nature.  
 Fig. 2. Scale of the flank, magnified.  
 Fig. 3. Scale from the lateral line, magnified.

P. DE M. GREY EGERTON.

*Oulton Park*, Nov. 15, 1860.



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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 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.]

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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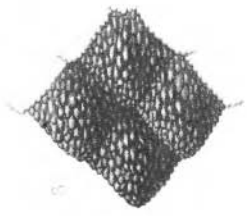
#### EXPLANATION OF PLATE VI.

- 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.*

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# 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 laminae 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 Mitchelli*, size of nature.  
Fig. 2. The same drawn in detail, twice the size of nature.  
Fig. 3. Scales highly magnified.

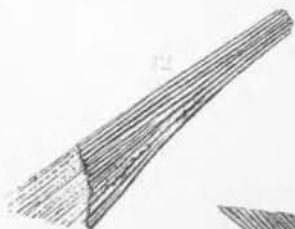
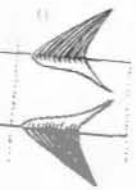
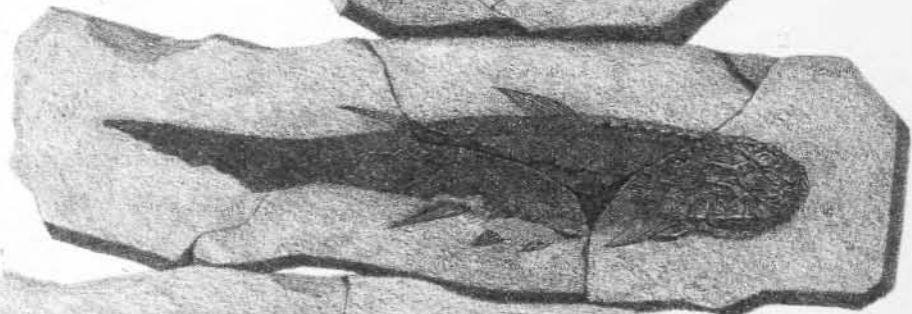
P. DE M. GREY EGERTON.

*Oulton Park, December 1860.*





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# BRITISH FOSSILS.

## DECADE X. PLATE VIII.

### CLIMATIUS SCUTIGER.

[CLIMATIUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniopodoti. 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. scutiger* 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 scutiger*, 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 scutiger*. 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 scutiger*. 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.

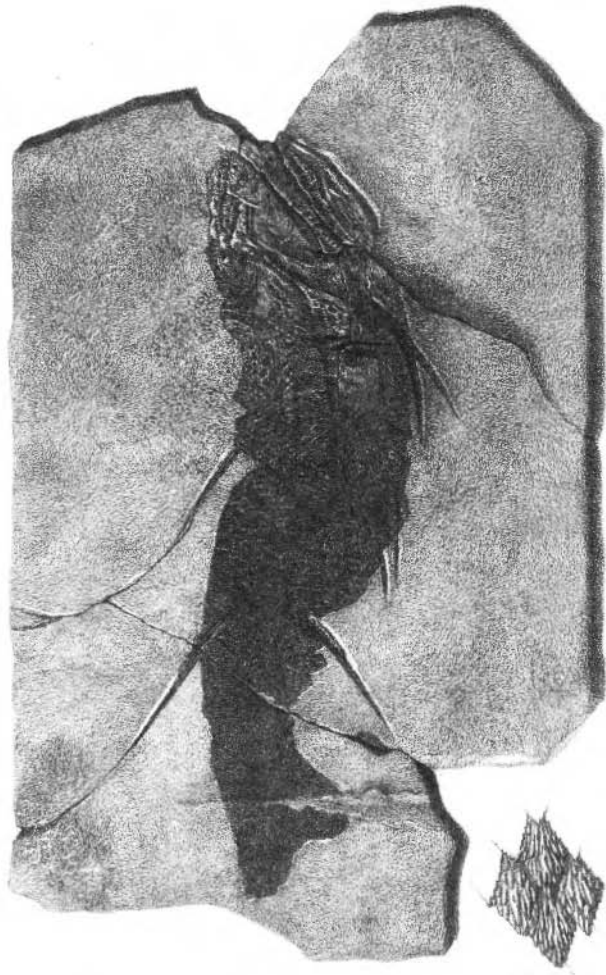
The last three figures are the size of nature.

P. DE M. GREY EGERTON.

Oulton Park, December 1860.

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# 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 Goniolepidoti. 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

*scutigera*, *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.

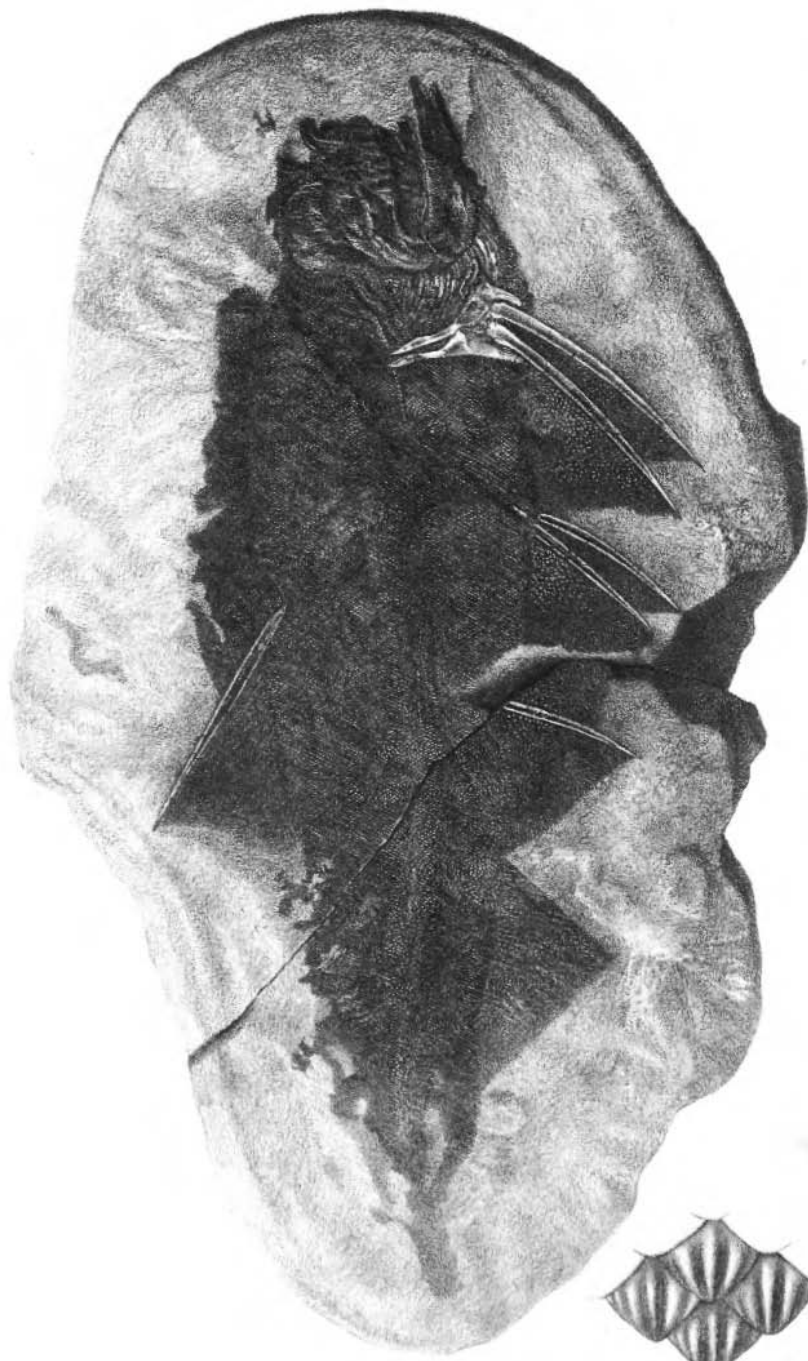
Fig. 2. Scales highly magnified.

P. DE M. GREY EGERTON.

*Oulton Park, January 1861.*



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CHEIRACANTHUS LATUS. Egerton.

Geological Survey of the United Kingdom.

# 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, unbonated 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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