

- FIG. 3, 3a. *Nerinea cingenda*, Phil. Dogger, Blue Wyke. Leckenby Collection.
 „ 4, 4a. *Nerinea cingenda*, Phil. Same locality and Collection.
 „ 5, 5a. *Nerinea cingenda*. Young specimen. Dogger, Blue Wyke. York Museum.
 „ 6, 6a. *Nerinea*. Dogger, Blue Wyke. Leckenby Collection.
 „ 7. *Nerinea*. Whitwell Oolite. York Museum.
 „ 8. *Nerinea*. Millepore Rock, Cloughton. Herries Collection.
 „ 9, 9a. *Nerinea cingenda*, Sow. Dogger, Blue Wyke. Leckenby Collection.
 „ 10, 10a. *Nerinea* “*fasciata*, Voltz.” Cornbrash, Scarborough. Leckenby Collection.

(To be continued.)

IV.—REMARKS ON THE GENUS *MEGALICHTHYS*, AGASSIZ, WITH DESCRIPTION OF A NEW SPECIES.

By Dr. R. H. TRAQUAIR, F.R.S., F.G.S.

(PLATE V.)

THERE can be no doubt that the name *Megalichthys* was originally suggested to Agassiz by the gigantic teeth of the great round-scaled fish first brought into notice by the researches of Dr. Hibbert, in the quarries of Burdiehouse, though indeed some of its remains had long previously been figured by Ure in his “History of Rutherglen and East Kilbride.” Incontrovertible evidence of this may be found by referring to the Proceedings of the British Association for 1834, and to Dr. Hibbert’s original memoir on the Burdiehouse Limestone published in the Transactions of the Royal Society of Edinburgh, vol. xiii. 1835. But with the remains of this enormous creature were also associated and confounded certain rhombic glistening scales, belonging really to a considerably smaller fish of a totally different genus, and when Agassiz, subsequently to the meeting of the British Association at Edinburgh in the year above quoted, found in the Museum at Leeds a head of this latter form, or at least of an allied species, he adopted *it*, by description and by figure, as the type of his *Megalichthys Hibberti*,¹ relegating the other to the genus *Holoptychius*. This latter, the real “big fish,” is now known as *Rhizodus Hibberti*, the founder of the genus being Prof. Owen; and though it may be a matter of regret that it did not retain the name *Megalichthys*, the laws of zoological nomenclature do not admit of any alteration now.

The brilliantly enamelled scales, head-plates, and teeth of *Megalichthys* are among the commonest vertebrate remains found in the estuarine beds of the Carboniferous epoch in Great Britain; nevertheless, specimens showing the fish itself in any but a very fragmentary state are rare, and though the head is very well known, from the magnificent specimen at Leeds figured by Agassiz, no concise description of the configuration of the body or of the arrangement of the fins has yet been given. It was classed by Agassiz in his heterogeneous group of “*Sauroides*,” but the resemblance of its scales and head-plates to those of the Old Red Sandstone genera *Osteolepis* and *Diplopterus* did not escape the attention of Sir Philip

¹ Poissons Foss. vol. ii. pt. 2, pp. 89–96, pl. 63, 63a, and 64.

Egerton, who, in Morris's "Catalogue of British Fossils," proposed its reference to the family of "Sauroidei-dipterini" (*Sauroidei-dipterius*) instituted by Agassiz for *Dipterus* and the genera just mentioned. From this group, however, M'Coy very properly struck out *Dipterus*,¹ which from its rounded scales he classed as a "Coelacanth," and which we now know is in fact a Dipnoan, allied to *Ceratodus*. The probable position of *Megalichthys* in the "Sauro-dipterini" was also indicated by Pander, who mentioned its close relationship to *Osteolepis* in the arrangement of its head-bones, the shape of its scales and teeth, and, above all, in the microscopic structure of its hard parts, though he also seemed to hesitate on account of our want of knowledge of the conformation and position of its fins.² A similar opinion, coupled with a similar hesitation, is expressed by Prof. Huxley in his well-known essay on the Classification of the Devonian Fishes.³

Prof. Young, in a paper on "Carboniferous Glyptodipterines,"⁴ makes some observations on *Megalichthys*, including a statement that "since 1861 specimens illustrating the form of the fins have been acquired by the Museum (Jermyn St.); but the description and illustration of these parts are reserved." I am not aware of any account of these specimens having been yet published. An important point is however his abolition of M'Coy's genus *Centrodus*, as a mere synonym of *Megalichthys*. *Centrodus* was founded upon a detached tooth from the Coal-measures of Carlisle, Lanarkshire.

Mr. J. Ward, in a paper on the fishes of the North Staffordshire Coal-field, classes *Megalichthys* in the family Saurodipterini, and states, moreover, that in a specimen in his collection the pectoral fins are well preserved;—"They are lobate, i.e. the central portion, of the fin is covered with scales, the fin-rays forming a fringe round the lobe."⁵

There can be no doubt that the position of *Megalichthys* is in the family of Saurodipterini, as defined by Pander, and adopted by Huxley and other writers. In every matter of "family" importance its structure conforms closely to that of *Osteolepis*.

The resemblance of the scales in external form is sufficiently obvious to every one, and their close correspondence in microscopic structure may be seen by comparing the figures of transverse sections given by Williamson in *Megalichthys*,⁶ by Pander in *Osteolepis*.⁷

As regards the osteology of the head, the resemblance is exceedingly close between *Megalichthys* and the Old Red Saurodipterines, as is at once evident on comparing the figure of the head of *Megalichthys* given by Agassiz with those of *Osteolepis* given by himself, by Hugh Miller,⁸ and by Pander. It is not within the scope of the present paper to enter into a minute or even a general account of

¹ British Pal. Foss. pp. 590-502.

² Die Saurodipteren, &c., des devonischen Systems, p. 5.

³ Dec. Geol. Survey, x. 1861, p. 12

⁴ Quart. Journ. Geol. Soc. vol. xxii. 1866, pp. 596-608.

⁵ North Staffordshire Nat. Field Club; Addresses and Papers, Hanley, 1875, p. 228.

⁶ Phil. Trans. 1849, pl. xlii. fig. 18.

⁷ Saurodipteren, etc., pl. v. fig. 8.

⁸ Footprints of the Creator.

Saurodipterine cranial osteology ; a few points may however be conveniently alluded to.

1. The polygonal plates covering the ethmoidal region between the frontals and the præmaxillæ are often more or less distinct in *Megalichthys*, as in small specimens of *Osteolepis*; often they are fused with each other, and with the adjacent bones named above, as seems always to be the case in *Diplopterus*.

2. Though Agassiz made a singular mistake with regard to the nasal openings of *Megalichthys*, he was perfectly correct in recognizing the anterior position of the orbit, and in assigning to it a situation exactly corresponding to that in *Osteolepis*. Prof. Young, of Glasgow, has, however, in a brief notice of a head of *Megalichthys* belonging to Mr. John Smith, Kilwinning, Ayrshire,¹ stated that the two outer plates of the posterior half of the cranial shield, which he calls "anterior frontal" and "squamosal" (*posterior frontal and squamosal* of the nomenclature adopted by myself), bound the orbit above. This would certainly put the orbits into a position very different from that which they occupy in *Osteolepis*. By the kindness of Mr. Smith, I have had an opportunity of examining the specimen in question, and though I find that on one side there is in the position indicated a triangular space formed by a displacement of the adjacent cheek-plates, I fail to see how it can be interpreted as an orbit, while, on the other hand, the position of the real orbit can, I think, be readily enough recognized in the place where we would expect to find it.

3. I have not seen in any specimen of *Megalichthys* the foramen which occurs between the frontal bones in *Osteolepis* and *Diplopterus*.

4. Although omitted in Miller's and Pander's figures, lateral jugular plates are undoubtedly present in *Osteolepis* and *Diplopterus*, as well as in *Megalichthys*.

The microscopic structure of the teeth of the Old Red Sandstone Saurodipterines is not yet fully elucidated; so far however as external shape goes, there is nothing of sufficient importance to exclude *Megalichthys* from the group.

Then as regards the fins. The Saurodipterini have obtusely lobate pectoral and ventral fins, two narrow dorsals, one similarly shaped anal, and a caudal, which may be heterocercal (*Osteolepis*) or diphycercal (*Diplopterus*). *Triplopterus* of McCoy, supposed by him to have only one dorsal fin, is a genus which is really non-existent, as it was founded on a specimen of *Osteolepis* compressed in such a manner as to show both ventral fins, one of which was mistaken for the single dorsal. The dorsal fins vary in position in *Osteolepis* and *Diplopterus*, being in the latter opposite the ventrals and anal respectively, while in *Osteolepis* the first dorsal is in advance of the ventrals and the second opposite the space between the ventrals and the anal. Now we have already seen that the lobate form of the pectoral in *Megalichthys Hibberti* was not unknown; it is noticed by Mr. Ward,² and was indeed incidentally alluded to long before by Agassiz³ himself, in describing what he supposed to be the ventral

¹ Pr. G. S. Glas. iii. 1868, 202-3. ² *l.c.* ³ Poiss. Foss. du vieux Grès rouge, 63.

fin of *Glyptolepis*, but which was in reality a portion of the pectoral.¹ A specimen from the Coal-measures of Dalkeith. in the Edinburgh Museum of Science and Art, shows also very clearly the obtuse scaly central lobe, with its fringe of fin rays.

As regards the other fins, their number and position are clearly shown in a specimen from the Coal-measures of Airdrie, Lanarkshire, in the British Museum. There are two posteriorly situated dorsal fins, which are placed as in *Diplopterus*, the first opposite the ventrals, the second very nearly opposite the anal. Part of the caudal is shown, but it is unfortunately not in a very perfect condition.

The best display which I have seen of the fins of *Megalichthys* is, however, the specimens from Burdiehouse, which form the especial subject of the present communication.

No doubt, in applying the name *Megalichthys Hibberti* to the specimen at Leeds, Agassiz believed that he had before him the head of the same species, whose rhombic enamelled scales he had previously seen from Burdiehouse at the Edinburgh meeting of the British Association: there was not indeed material at the time for deciding otherwise. But the Burdiehouse *Megalichthys* is now represented by more than a few detached scales and bones, the entire contour of the fish, the arrangement of the fins and many details regarding the head being displayed in specimens in the Edinburgh Museum and in other collections. Now there are certain points which satisfy me pretty fully that the Burdiehouse fish is different specifically from the common Coal-measure form, of which the head at Leeds is the type, and it might indeed be disputed whether the former has not a prior claim to the specific name "*Hibberti*," especially as some of its scales and bones were actually figured under that name, along with remains of *Rhizodus*, by Dr. Hibbert in his classical memoir before the publication of Agassiz's account of the latter in the "*Poissons Fossiles*." But the fact that Agassiz, the founder of the genus and species, definitely adopted the Leeds specimen as the type of the first scientific description of *Megalichthys Hibberti*, coupled with the natural feeling that except on really imperative grounds it is not wise to disturb long-established names, is, I think, sufficient justification for allowing it to retain the name which it has borne now for forty years.

Proceeding now to the description of specimens, the first which may be noticed is one in the Edinburgh Museum (Hugh Miller Coll.), which is pretty entire though small (Pl. V. Fig. 1). It measures $10\frac{3}{4}$ inches in length, though it must be noted that the rays of the caudal fin are somewhat frayed and broken at their extremities: the greatest depth of the body is $1\frac{3}{4}$ inch; the length of the badly-preserved head is $2\frac{5}{8}$ inches. The pectoral fin is not shown, but all the others are, though perhaps not in so complete a state of preservation as might be wished. There are two dorsal fins, of which the anterior one is the smaller, and commences $6\frac{1}{2}$ inches from the front, while the second arises $1\frac{1}{2}$ inch further back. The ventral arises opposite a point rather behind the origin of the first

¹ Pander, *op. cit.* p. 68; Huxley, *op. cit.* p. 7.

dorsal, while opposite the second dorsal is an anal fin of moderate size, but whose rays are unfortunately rather broken up. The caudal is pretty well shown, but not so well as in the next specimen, in which the form of the tail and of the second dorsal and anal are exceedingly well displayed. Fig. 2 represents the caudal extremity of this specimen, which is 14 inches in length, but originally it must have been considerably longer, as it wants the head, and I should imagine also a good bit of the body. The caudal fin here shown may be said to be somewhat intermediate between the diphyccercal and heterocercal types, at least it is not quite so heterocercal as that of *Osteolepis*, and in general form reminds us of that of *Tristichopterus*. Rays arise from both the upper and lower margins of the body-continuation, but those of the lower side commence in advance of those of the upper. After the commencement of the rays, the upper margin of the body-prolongation slopes very little downwards, while on the other hand the lower one slopes very rapidly upwards; the two margins then converge to a point which is lost among the fin-rays, the scaly covering being lost at this part. The posterior margin of the fin slopes obliquely upwards and backwards, the greater number of the rays arising from the lower aspect of the body-prolongation, while the apex, cut off in the specimen, would seem to be formed by rays arising from the upper or dorsal side of the axis.

On the dorsal aspect of the specimen, and just in front of the caudal, is the second or posterior dorsal fin. The anterior margin of this fin measures $2\frac{3}{4}$ inches; it has a narrow scaly base, and expands somewhat distally; its apex is bluntly pointed. Opposite this upon the ventral aspect is the anal fin, of the same length, but rather more lanceolate in shape.

The pectoral fins are well shown in a specimen in my own collection: they are short, and obtusely rounded, with an obtuse basal scaly lobe fringed with rays. The lobation of the ventrals seems to be not quite so marked. All these fins are composed of numerous closely-set rays, divided by very close transverse articulations, except quite at their proximal extremities, which are covered by the scales of the body: they dichotomise towards their extremities, and their free surfaces are brilliantly ganoid and punctated like the scales.

Scales.—The scales present the same appearance externally as in *M. Hibberti*, and are not to my eye distinguishable. Their internal surfaces are seldom seen, and appear sometimes furnished with the prominent keel seen in *M. Hibberti*, while in other instances this appears to be absent.

Vertebral Column.—A specimen in the Museum of Science and Art shows the presence of ring-shaped vertebral centra, as in *M. Hibberti*.

Head.—Fig. 3 represents, reduced in size, a very instructive head in the Hugh Miller Collection, in which the cranial shield is very well shown. This is as usual divided across into two portions, an anterior or fronto-ethmoidal, and a posterior or parietal; but in this instance the anterior portion is longer by one-seventh than the posterior one in *M. Hibberti*; on the other hand, the posterior moiety is the longer. Taking the parietal part of the buckler, it may also

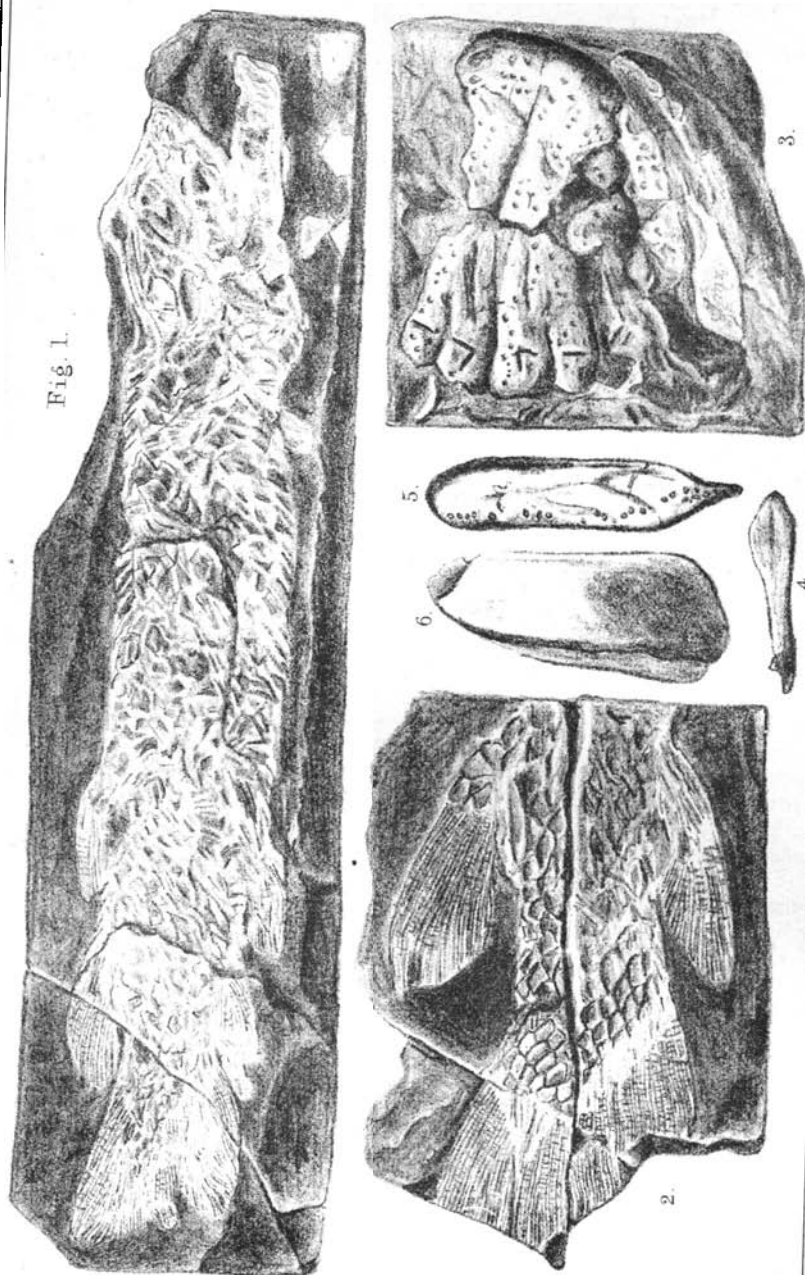
be seen to differ in shape from that in the ordinary species, in being proportionally broader in front. The plates of which it is composed seem pretty completely fused together, as the indications of their original separation are slight and principally seen posteriorly. Near the hinder margin are also seen certain grooves like those observable in a similar situation on the cranial shield of *Osteolepis* and *Diplopterus*. One of these passes transversely across the middle of the squamosal element: another is V-shaped, one leg of the V continuing the direction of the former across the posterior part of the parietal, from the outer margin to about the middle of the bone, whence the other leg then diverges outwards and backwards towards the posterior margin. These grooves in *Osteolepis* were supposed by Pander¹ to indicate the original presence here of elements equivalent to the transverse supratemporal chain in *Polypterus*, but a careful examination of the under surface of Saurodipterine cranial shields, showing the sutures and centres of ossification, proves that this is not the case, and that the grooves in question are mere superficial markings. The supratemporals are according to my interpretation represented in this family and in allied forms by the three plates, one median and two lateral, which lie immediately behind the shield, and which are lettered by Prof. Huxley in *Glyptolæmus* as supraoccipital and epiotics.² The anterior or fronto-ethmoidal part of the shield in this specimen has its constituent elements completely ankylosed, so that not even the frontals are separately recognizable. On each side the margin is slightly excavated for the upper boundary of the orbit; the anterior margin is convex and expanded to form the rounded snout; the nasal openings are not visible. The whole surface of the buckler, besides the minute punctation of the glittering enamel, is covered with small scattered rounded openings, apparently the orifices of "mucous" ducts.

The posterior part of the cranial shield, detached, is well shown in another specimen. This, when compared with the corresponding part in *M. Hibberti*, shows the same greater proportional breadth in front seen in the last described example, but the sutures between its six constituent bones, viz. the paired parietals, squamosals and posterior frontals, are distinctly marked, and the slime-canal apertures, similarly scattered over the surface, are very much smaller. The peculiar grooves on the posterior part of the shield, alluded to above, are also here so slightly marked as to require a lens for their definition.

Returning to the former head (Fig. 3) we find that though the operculars are gone, and most of the other superficial bones fractured and badly seen, the maxilla and mandible occupy their positions. The *maxilla* (*mx*), the anterior portion of which is deficient in this specimen, at once attracts attention by its narrow shape. It is shown in its entirety in the specimen represented in Fig. 4, where it is seen to differ from that of *M. Hibberti* in the much smaller depth of its posterior expanded portion, that being contained $4\frac{1}{2}$ times in its length, whereas in that species it is only contained about 3 times.

¹ *op. cit.* p. 11.

² *op. cit.* p. 2, fig. 2. On this subject see my memoir on *Tristichopterus alatus*, Trans. Roy. Soc. Edinb. vol. xxvii. (1875) p. 386.



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Megalichthys laticeps, Traquair

The same fact being observable in two separate specimens, it cannot be looked upon as a mere accidental variety in shape.

The *mandible* (Fig. 5) seldom exhibits the oblique groove, indicating the original separation of the dentary element, which is so often observed in *M. Hibberti*. Jugular plates were present; *principal* (Fig. 6), *median* and *lateral*, but these do not call for any special comment; nor do the opercular bones, which are sometimes found detached, and exhibit the ordinary shape.

The teeth are seldom seen: when visible, they appear rather smaller in proportion than in *M. Hibberti*, though of the same general appearance. The scales and superficial bones of the head have their free surface covered with a layer of smooth and brilliant ganoiné, which under a lens shows a minute punctation quite similar to that in *M. Hibberti*.

The difference in shape of the maxilla and of the parietal portion of the cranial shield are to my mind sufficient evidence that the *Megalichthys* of Burdiehouse is specifically different from *M. Hibberti*; but I have no doubt that when both species are more minutely examined and described, many other points of distinction will be found. For the form above described, which is certainly still less likely to be confounded with either the *M. coccolepis* or *M. rugosus* of Young and Thomson,¹ I propose the name of *Megalichthys laticeps*. Possibly its remains may include those of *Diplopterus Robertsoni*, Ag.; but as this is a mere MS. name, to the original of which there is now no clue, it must be simply cancelled.

Its remains are for the most part considerably smaller than those of the common Coal-measure species, though patches of scales occur showing that it sometimes attained a size nearly as great.

The fact that this species, of Calciferous Sandstone age, is distinct from any yet found in the Coal-measures, is in accordance with the result of all my experience in the domain of British Carboniferous Ichthyology, namely, that very few species of Ganoids are common to the strata above and below the Millstone Grit. As regards *Megalichthys*, however, it must also be mentioned that its scattered remains are not uncommon in the estuarine beds of the Scottish Carboniferous Limestone Series, but as yet I have seen no specimen on which any secure determination of species can be founded.

EXPLANATION OF PLATE V.

All the specimens figured are in the Edinburgh Museum of Science and Art.

- FIG. 1. *Megalichthys laticeps*, Traq. Entire specimen, reduced: original $10\frac{3}{4}$ inches in length. Hugh Miller Collection.
 „ 2. *Rinder* extremity of another specimen, showing the second dorsal, anal, and caudal fins: reduced one-half.
 „ 3. Head of another specimen showing the cranial buckler, maxilla and mandible: reduced more than one-fourth. Hugh Miller Collection.
 „ 4. Maxilla, from another head: natural size. Hugh Miller Collection.
 „ 5. Mandible reduced, placed upright to save space: original $2\frac{1}{2}$ inches long.
 „ 6. Principal jugular plate, reduced: original $2\frac{1}{2}$ inches in length.

¹ Proc. Brit. Assoc. 1869 (Exeter), Trans. of Sections, p. 102. As regards other species of *Megalichthys*, *M. maxillaris*, Ag., was never described or figured; *M. prisca*, Ag., from Orkney, was afterwards referred by Agassiz himself to *Polyphractus* (i.e. *Dipterus*); while *M. Fischeri*, Eichwald, is pronounced by Pander to be portion of the cranial shield of an *Osteolepis*.