3. *On a new LABYRINTHODONT AMPHIBIAN from the MAGNESIAN LIMESTONE of MIDDERIDGE, DURHAM.* By ALBANY HANCOCK, Esq., F.L.S., and RICHARD HOWSE, Esq.

(Communicated by Prof. Huxley, F.R.S., F.G.S.)

[PLATE XXXVIII.]

Among the important additions to the fauna of the Permian rocks of Durham made by Joseph Duff, Esq., last autumn, not the least interesting, perhaps, may be reckoned the remains of a Labyrinthodont having numerous finely striated, rhombiform scutes or scales, resembling in shape those of some Ganoid fishes, though very superior in size. These remains were found at the Midderidge quarry (a portion of which has recently been removed for the purpose of widening the Darlington and Wear-valley Railway), in a bed of yellow marly limestone 7 or 8 feet above the marl-slate properly so called. The section at this quarry is thus described by Prof. Sedgwick, Geol. Trans. ser. ii. vol. iii. p. 76:—

“1. Bed of light-coloured siliceous sandstone, worked as a coarse flagstone and also as a building-stone. The upper beds alternate with blue-coloured calcareous shale. At East Thickley they are about 30 feet thick.

“2. Yellow-coloured calcareous shale and shale-slate, in thickness about 9 feet. Some of these beds are incoherent and sandy; the marl-slate forms a series of indurated bands, which divide the more incoherent shale.

“3. A series of thin beds with marly partings; the whole about 20 feet thick. The average thickness of the several beds is not more than a few inches; their surfaces are often covered with yellow marl; at their natural partings they are generally covered with dendritical impressions,” etc.

In the above section, No. 1 represents the uppermost member of the Coal-measures, which in this part of Durham have been much disturbed and denuded prior to the deposition of the Marl-slate. It must be mentioned that in this quarry and in the south of Durham there is no bed of “yellow incoherent sand,” a bed which forms an important item in the section a few miles further north and in the north of Durham generally.

The Marl-slate proper equals the lower portion of No. 2 of Prof. Sedgwick's section. When closely examined, it can be distinctly separated from the marly limestone, into which it gradually passes upwards. And it is more emphatically distinguished by the fossils it contains; for, though a few stray fishes are now and then found in the calcareous beds above, yet this lowest part is the depository for the numerous fish- and plant-remains which characterize the Permian rocks. It is, then, in the middle, or nearly so, of this yard of Marl-slate that Mr. Duff has found the remains of the *Dorypterus Hoffmanni*, Germar, and also the remains of two species of reptiles, viz. *Proterosaurus Speneri*, H. v. Meyer, and *Proterosaurus Huxleyi*, nov. spec., descriptions of which have been communicated to the Geological Society. Associated with these occurred numerous re-

mains of the fishes which have been so long well known, and fragments of plants, a few of which are new to England, though most of them have been described from the Kupferschiefer of Germany. The Mollusca observed by Mr. Duff consist of fragments of *Nautilus Freieslebeni*, Schloth., specimens of *Discina nitida*, Phil., *Lingula mytiloides*, Sow., and *Myalina Hausmanni*, Goldf. Of these shells, only a few imperfect specimens occurred. The appearances presented by the whole of the fossils entombed in this Marl-slate seem to lead to the conclusion that this deposit was formed in a very quiet estuary, into which the land reptiles and the freshwater Ganoids and the remains of coniferous plants were brought, to be intermixed with other exuviae, such as the shells of *Nautili*, *Discinae*, and *Lingulae*, which are undoubtedly of marine origin.

The Marl-slate at this spot appears to be perfectly unconformable to the Coal-measures No. 1 of the above section. But between it and this sandstone there is an accumulation of yellow unctuous clay, about 2 feet thick, which has not the appearance of an original deposit, but appears to have been formed partly by the destruction of the lower part of the Marl-slate, and partly by the infiltration of water carrying in clayey particles through the extensive fissures which abound in the superincumbent limestone. Upwards the Marl-slate gradually passes, becoming more calcareous according to its height, into the thin-bedded compact limestone No. 3 of Prof. Sedgwick's section. It is in these transition beds, at about 7 feet above the Marl-slate proper, that our new Labyrinthodont was found. The beds of this portion are much thicker than in the compact limestone above, and more marly, and contain here and there small accumulations of gritty materials surrounded by hard compact limestone. The amphibian itself seems to have been imbedded in a very compact nodulous mass of one of these beds, and was fortunately brought to light by the splitting of the stone right through the central portion of the bed. In this part of the series at this quarry the only other fossil remains found were a few *Lingulae* and fragments of a Polyzoan; but in a neighbouring quarry the beds on this horizon contain numerous remains of the well-known Permian mollusca. Although found in this higher portion of the series, we imagine there will be no difficulty in inferring that the remains of this creature were carried from its freshwater haunts to be imbedded in a deposit which was fast putting on a marine aspect.

The specimen of this new and interesting form (Pl. XXXVIII. fig. 1), for which we propose the name of *Lepidotosaurus Duffii*, is unfortunately in a bad state of preservation, owing partly to the crystalline condition of the matrix, and partly to the peculiar state of the bones, some of which look as if they were composed of dark grey carbonate of lime, while certain parts of them have a burnt appearance, and are reduced to a brittle, white, flaky, chalk-like substance, conspicuously displaying the concentric layers of growth. The fossil lies on its side, and is seen in vertical section, part of the bones being on one slab and part on the counter slab. The backbone (*a, a, a'*) is split open longitudinally, there having been a natural division through this

part. The ribs (*e, e, e*) are divided in the same direction; but they for the most part are torn asunder, as the division has not extended much beyond the backbone. The same may be said of the head (*b, c, d*), which lies split open horizontally below the ventral margin of the animal. The neck (*a'*) is curled round in front of the anterior end of the body in the direction of the head, which lies in a reversed position, as we have just seen, below the trunk, which to some little extent overlaps it. The tail or posterior end of the spine seems to have been turned round the hinder extremity towards the same region, but none of its bones are present; only an indistinct depression indicates the fact.

As the body lies thus curled up, it measures 15 inches in length; and in width, from the backbone to the distal extremity of the ribs, 8 inches. The length of the specimen, including the head if stretched out, would be about 35 inches.

The course of the backbone is obvious enough, running along the dorsal margin, turning round in front of the body, and curving backwards in the direction of the occipital region of the skull; but, unfortunately, at this point the slab is broken away for upwards of 2 inches, separating by that space the head from the spine. The vertebral column (*a*), as seen in longitudinal section, is about an inch and one-eighth wide; but it is quite impossible to make out any of the characters of the vertebræ, or even to determine their dimensions with the necessary precision. All that can be said on this point is that, from the assumed extent of four consecutive vertebræ, the length of a single vertebra may be estimated at about seven-eighths of an inch. This difficulty arises partly from the crystalline condition of the whole line of the vertebræ, and partly from the fact that the whole of the bone is broken up and partially removed, little else than cellular or flaky matter remaining, all boundaries determining the forms of the parts having disappeared.

There is, however, one feature of the vertebral column which cannot pass unnoticed. The neck (*a'*) seems to have been remarkably long for a Labyrinthodont. From the length of the ribs, the body must undoubtedly have been of considerable depth; and unless the neck had been long, it is evident that the head, if attached to the trunk, as it appears to have been when deposited, could not have assumed the position in which it is placed immediately below and parallel to the belly. But it is impossible to determine the exact length of this portion of the column, as we cannot be sure how many of the anterior ribs are wanting.

The ribs (*e, e, e*) are arranged in regular order, inclining from before backwards; but have been apparently torn bodily from their spinal attachment by pressure after deposition, and now their proximal extremities are removed about an inch and a quarter from the column, the whole having been afterwards pushed downwards. Twenty-one are distinctly displayed in parallel order, about a quarter of an inch apart from each other in front; but the space dividing the posterior ones is somewhat greater. They are inclined diagonally from the front in slightly arched curves, the concavity being forward; and traces of eight or ten more can be determined, so that in all there

have been about thirty ribs. In front, too, there are indistinct impressions of one or two more; but whether or not these terminate the series in this direction, it is impossible to say.

The largest ribs, which are near the centre, are $6\frac{1}{4}$ inches in length, following the curve, and the shaft is one quarter of an inch thick; they taper slightly towards the distal extremity, and do not exhibit the longitudinal groove or depression usually observed in the ribs of Labyrinthodonts, neither are they apparently depressed in the usual manner. The proximal extremities are crushed and broken, but are widened a little, indicating a double articular surface; these extremities are, however, too imperfect to warrant any confident assertion of the fact.

The greater number of the ribs have a crystalline appearance, as if composed of a dark grey carbonate of lime; but the concentric bone-layers are for the most part conspicuously displayed. Eleven or twelve of the anterior ribs have more than an inch of their distal extremity broken away, and the ruptured ends are united to an irregular, narrow, thin, longitudinal belt of bone (*f*), which is in the same crystalline condition as the ribs, and which has a fanciful resemblance to a fragmentary breast-bone; but this appearance is altogether illusory, for, though this long belt is completely incorporated with the extremities of the ribs, the result merely of pressure, it is undoubtedly composed of the remains of a few of the dermal scales to be afterwards described.

The limbs are not present, nor can any trace of them be observed. There is, however, a thickish mass of bony matter in the dorsal region in front (*g, g*), lying incorporated with the proximal extremities of eight or nine of the anterior ribs, and extending in advance of them nearly as far as the curved line of the cervical vertebræ. This may, perhaps, be the remains of the scapulæ and other members of the shoulder-girdle; but the forms of the parts are entirely obliterated; indeed there is no indication of the mass having been composed of distinct parts. The thickness of the bone, which, however, cannot be easily accounted for in any other way, justifies the above supposition; and in fact, from its extent, measuring as it does 5 inches long and nearly 2 inches wide, the fair inference would seem to be that the fore limbs must have been largely developed.

There is, however, another explanation which has been suggested, which, though possible, can scarcely be considered probable: it is that this bony mass may be the remains of the large pectoral plates found in all Labyrinthodonts, which in some way or other have been removed thus far from their natural position. But this bony mass lies united to the ribs, and is covered by the dermal scales already alluded to, which appear to be undisturbed. This could scarcely be the case did this bony mass originate in the transported pectoral plates.

Further back, incorporated with the dorsal extremities of the ribs there situated, is another considerable accumulation of bony matter (*h*) in the form of a very irregular elongated belt. The greater portion of this is undoubtedly derived from the surface-scales and

the crushed ribs. At the anterior part of the belt, however, the bony substance is too thick to be thus accounted for, and, had it been placed sufficiently far backwards, it might have been supposed to be the remains of the pelvic girdle; but we fear its nature must be left undetermined.

The head, we have already observed, is seen in section, lying in a reversed position below the ventral margin, which to a limited extent overlies it, the muzzle being directed backwards (*c, b, d*). The coronal portion is on the slab on which the right side of the trunk rests; the lower or basal portion and muzzle are on the other, which may be denominated the left slab, as it contains the left side of the trunk.

The cavity of the cranium was filled with crystallized carbonate of lime, and the bone is in a very flaky tender condition, having a chalky or burnt appearance; and in some places it is so much reduced as to be difficult to trace; neither the sutures of the component bones nor much of the surface character can be determined.

The entire length of the skull is $9\frac{3}{4}$ inches; but the extremity of the muzzle is wanting. The occipital region is much injured; it is wide, truncated, and angulated at the sides; it measures across $5\frac{1}{4}$ inches: for about an inch forward the skull widens a little, and then suddenly tapers for nearly an inch and three-quarters, at which point it is 3 inches wide; here the muzzle seems to commence, and from hence it tapers gradually to the broken anterior extremity, where it is a little more than an inch and a half wide.

The portion that remains of the narrow elongated muzzle is in a better state of preservation than the rest of the skull, and is 7 inches long, and measures across the centre $2\frac{1}{2}$ inches. Only a part of the upper surface was exposed; but, aided by the skilful manipulation of our friend Mr. Atthey, to whom our best thanks are due, we have been enabled to work out the features of this characteristic portion of the cranium. The matrix has been carefully removed by that gentleman from the sides, and has been dug away from beneath, so as to exhibit to some extent the palate. Thus revealed, the muzzle is seen to be much depressed, slightly convex above, with the roof of the mouth apparently flat, or only a little concave. The maxillæ, which seem to form the sides of the muzzle, are thick at the outer margins, but are quite thin above. Unfortunately, however, the roof of this portion is much injured; there is, nevertheless, a strip about half an inch wide extending the whole length of the maxilla, along the right side, and a small portion near the centre of the left maxilla, in a tolerable state of preservation. The central portion of the roof is, for the most part, deficient,—little more than the cast of it, showing the form.

The upper surface of the roof, or as much of it as remains, and the margins of the maxillæ are studded with small conical, bluntly pointed tooth-like processes, irregularly disposed, but nowhere crowded. They are largest at the outer margins of the maxillæ, where they incline outwards, and appear to diminish in length and to become erect as they pass inwards towards the middle longi-

tudinal line. They are for the most part broken down, merely tubercular scars marking their position ; but near to the centre of the left maxilla they are quite perfect, and are seen projecting into the adherent matrix, having much the appearance of minute teeth. The largest are one-sixteenth of an inch in length, and are rather obtusely pointed ; several of them are coated with a thin layer of transparent glass-like enamel. Their resemblance to teeth is still further shown by a large pulp-cavity and thick dentine-like walls, which have a white milky hue, and are very tender, being evidently much changed by fossilization. They are, however, apparently processes of the bone from which they project ; no distinct anchylosis can be seen, and when broken away there is no depressed scar, but their bases are persistent, like rugged tubercles.

Traces of similar tooth-like processes are found much further back on the sides of the skull. The palatal surface of the muzzle, so far as it could be explored, displays no teeth, neither does the outer or alveolar margin of the maxillæ ; but not much importance can be placed on these negative facts when the peculiar state of the specimen is considered. Very little can be added to what has already been said respecting the other portions of the cranium. After carefully removing the crystalline carbonate of lime from the interior of both portions of the skull, its walls are found distinctly lining the concavities in the matrix, though in places the bone is reduced to mere traces. And in one part the coronal wall has been thrust inwards, apparently by some disturbance in the matrix ; and the general distortion is so extensive that little can be determined except the contour, which has been already described, and this is not by any means perfect (see Pl. XXXVIII. fig. 2). The crown seems to have been considerably elevated and arched.

Perhaps the most interesting, and certainly the best-preserved feature of our strange amphibian has yet to be noticed. As it lies, it seems to have been covered with large, minutely striated, bony, imbricated scutes or scales, which extend from end to end and from the dorsal to the ventral margin of the specimen. These scales are arranged in diagonal lines, sloping from behind forwards, and give to the surface of the animal a strongly ribbed appearance in the same direction. The inside view of the scales presents the same sort of ribbing as the exterior ; indeed both sides of this bony armature remind the observer of the ridges and furrows of a tiled roof, only the individual scales are not distinguishable as the tiles of a roof are ; the ridges and furrows alone are visible, and the junction of the rows is not perceptible. This may be partly owing to the pressure to which the fossil has been subjected, incorporating the bony scales with each other ; but it undoubtedly results in a great measure from the character of the scales themselves, which permit the most close and accurate fitting. However this may be, the specimen at present has the appearance of having been incased in a continuous bony shield coextensive with the trunk. No portion of the tail existing, it is impossible to say whether or not the scales extended to it.

Such is the general character of this peculiar scaly armature. Not much, however, of the external surface is seen; but a portion of two or three rows of the scales is well displayed at the anterior extremity of the ribs on the right slab, or that on which the coronal portion of the cranium is preserved. This patch of the scaly covering of course belongs really to the left side of the animal; it overlies the ribs, and in part covers the bony mass, which we suppose may be the remains of the shoulder-girdle. Other two considerable patches are observed overlying the ribs near the centre of the body, and several smaller patches are scattered over the specimen. All these patches exhibit the minute striation of the surface, and that in front displays also the ribbed structure; and the casts of all of them can be traced on the left slab. That of the anterior patch is well marked, and is of considerable extent, showing both the ridges and the minute striation of the surface.

Upon the left slab, too, the under surface of the scales is well seen, particularly a belt of a portion of four or five rows about an inch wide, that stretches along by the side of the vertebral column. And towards the posterior extremity of the specimen, the rows of scales are seen in their whole length (*i. i.*) extending in parallel order from the ventral to the dorsal margin, sloping forwards, and crossed by the ribs which incline in the opposite direction. The inside of the rows of the scales is equally well displayed on the right slab.

The scales themselves (fig. 3) are rhombiform, with the angles slightly rounded, and having projecting from the lower anterior angle a strong, pointed conical process, which is overlapped by the dorsal margin of the scale next below. They are transversely elongated, and measure in this direction an inch and three-quarters, lengthwise, or from the anterior to the posterior margin, five-eighths of an inch. We shall, however, merely for the sake of convenience, consider the long measurement as that of the length, the short as that of the width.

The ends, then, of the scales are truncated diagonally from above downwards and backwards; they (the scutes) are rather stout, but gradually thin out to the margins, which are very fine, and have a widish, thick ridge extending the whole length, much nearer to the front than the posterior margin, and parallel to it. This ridge is smooth and rounded below, where it is seen to be continued into the projecting process; above, on the outer surface, it forms an obtuse ridge the entire length of the scale. The anterior part of the outer surface is smooth as far back as this ridge, and is bevelled or sloped to the margin; the posterior portion is twice as wide as the smooth anterior border, and slopes or inclines in the opposite direction or backwards, so that the longitudinal carina is like the ridge of a very low-pitched roof with one of the slopes much shorter than the other. The wide posterior slope is minutely and closely striated, the striæ being raised, sharply defined, and slightly diagonal from above downwards and backwards, and are somewhat broken and tortuous.

The scales imbricate backwards, the anterior overlapping the

posterior as far as the longitudinal ridge, so that the whole of the smooth anterior border is covered, as well as the conical process projecting from the lower extremity; and the striæ of the surface become continuous from scale to scale, and in this way the whole of the scaly surface is covered with uninterrupted striæ. This is all the more perfect as the boundaries of the scales are not distinguishable, as already stated, the thin margins overlapping with great accuracy, and the pressure during fossilization undoubtedly aiding in obliterating the visibility of the junctions. The ridges and furrows formed by the rows of scales, and the striation of the surface, alone give evidence of the presence of this scaly armature; and had it not been for the aid of some isolated scales on the margin of the specimen, their form and character could not have been determined.

From the above description, the close resemblance of the scales to those of some ganoid fishes is sufficiently obvious; indeed they might very readily be mistaken for the scales of a gigantic *Platysomus*, the chief distinguishing feature being that there is no notch to receive the peg of the adjoining scale, the connexion being merely that of superposition.

Such are the characters of this curious Labyrinthodont, as they are determinable in our specimen, and they are certainly very anomalous. The most remarkable feature is the covering of uniform fish-like scales, which undoubtedly seem to clothe the entire body from back to belly; and were this really the natural condition of the creature, it would indeed be extremely abnormal, and we should be at a loss to ascertain its affinities, particularly as very little aid is supplied by the few other characters that we have been able to make out. Is it possible, then, in any way to account for this extraordinary appearance, so as to bring *Lepidotosaurus* into the category of the Labyrinthodonts? for it seems to have some relationship to that group, as is shown by certain cranial characters to be shortly referred to.

We are indebted to the kindness of Prof. Huxley for an answer to this question. After carefully examining the specimen, and considering it in every possible way, that gentleman suggested to us that, after all, the scales that now seem to be coextensive with the whole body may be nothing more than the ventral scutes common to all Labyrinthodonts, though somewhat modified in character and more extensively developed than usual.

The specimen, as we have already pointed out, lies on its side. Now these Amphibians have had depressed bodies; and as it may be supposed that the ventral scales would be developed in proportion to the degree of depression (or, in other words, those individuals with broad bellies would have more scutes than those with narrow bellies) it is easy to see that in *Lepidotosaurus* the scutes or scales, assuming the depression to have been extreme in this form, might have been more than usually developed. It is quite possible then, nay, even likely, that on the collapse of the ventral scales, under the influence of lateral pressure, the animal lying on its side, their

outer or upper margins of both flanks might reach to the dorsal region, covering up and enclosing the ribs, exactly as is the case with the specimen before us. The perfect imbrication and close interlocking of the scales would undoubtedly conduce to this end by maintaining their compact order.

This seems to us so natural an explanation of the phenomenon, that we gladly adopt it; and thus we find the greatest difficulty of the problem turned and conquered. We are also indebted to the liberality of Prof. Huxley for pointing out to us the affinity of our new form to *Dasyceps*, also a Permian Labyrinthodont.

The relationship to the latter is seen in the form and ornamentation of the head. In *Dasyceps* the muzzle is not by any means so much produced as it is in *Lepidotosaurus*; the form, however, of the occipital region presents considerable resemblance. But what is most remarkable is that the surface of the skull is covered with minute, sharp, tooth-like processes, quite similar to those before described on the muzzle and sides of the skull of our new form.

The Bradford fossil recently described by Prof. Huxley in the Quart. Journ. Geol. Soc. vol. xxv. p. 309, under the name of *Pholiderpeton scutigerum*, shows some relationship to *Lepidotosaurus* in the large development of the ventral scutes; but they differ greatly in character from those of the latter.

The extraordinary characters of the scales, their vast development, peculiar ornamentation, and perfect mode of imbrication, as well as the greatly elongated, narrow muzzle, and other characters of the head, make it necessary to establish a new genus for the reception of the Madderidge Labyrinthodont, to which, as previously stated, we have given the name of *Lepidotosaurus Duffii*, the specific name being in honour of the gentleman who has added so much to our knowledge of the vertebrata of the British Permian rocks.

EXPLANATION OF PLATE XXXVIII.

Fig. 1. Slab exhibiting the left side of *Lepidotosaurus Duffii*, two-thirds natural size:—*a*, *a*, *a'*, line of the vertebral column; *a'*, the cervical portion of ditto; *b*, the inferior portion of the skull; *c*, small piece of the upper wall of ditto bulged inwards; *d*, muzzle exhibiting at the sides minute conical tooth-like processes; *e*, *e*, *e*, ribs; *f*, belt of bony matter, resembling a fragmentary breast-bone; *g*, *g*, anterior mass of bony matter, supposed to be the remains of the shoulder-girdle; *h*, posterior ditto, nature undetermined; *i*, *i*, inside view of the rows of dermal scales; *j*, the dorsal extremities of four or five of ditto; *k*, impressions of the anterior or lower extremities of four or five rows of scutes of the right side, showing the ridges and furrows and the minute striation of the surface; *l*, *l*, patches showing the striated impressions of scales.

Fig. 2. Outline of cranium, dorsal view; one-third natural size.

Fig. 3. A scute, about the natural size.

Fig. 3
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